WORLD OIL

Preview of August 1 International Outlook Issue's report on oil' brightening prospects.
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CATC's four-string quad ruple completion is in dustry's first.
Page 9

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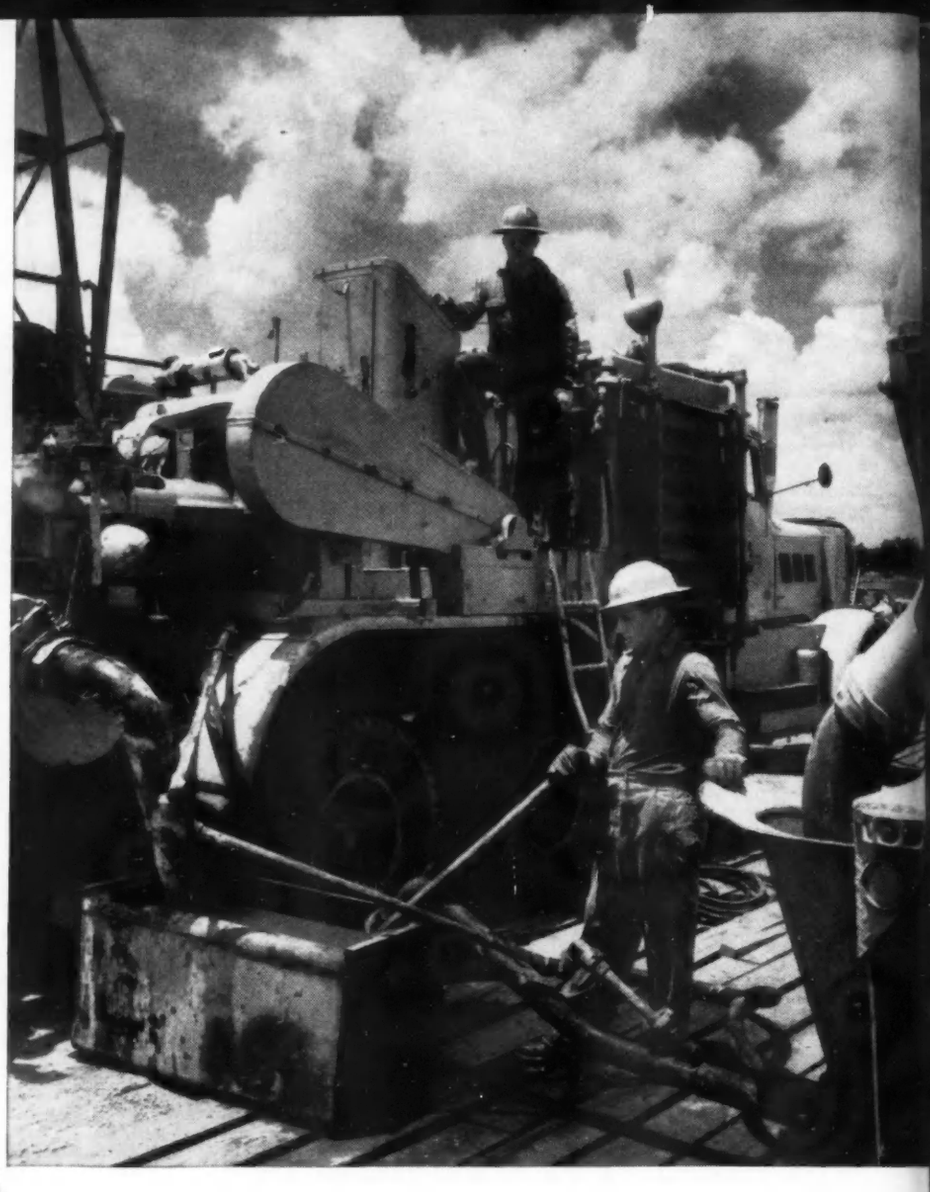

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Volume 147, No. 2 August 1, 1958

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WORLD OIL

Established 1916 as The OIL WEEKLY

a quick look at WORLD OIL this month

BUSY OIL MEN: To help you put first things first, scan these time-saving digests on this and the following pages, checking ☑ those you want to read first.

CURRENT OUTLOOK

☐ **Secondary recovery operations are boosting U. S. oil reserves.** Oil recoverable by fluid injection under present economic conditions amounts to 13.1 billion barrels, increasing by 42.8 percent the reserves of 30.6 billion barrels producible by primary recovery. These combined reserves of 43.7 billion barrels, plus the 57.8 billion barrels already produced, assure ultimate recovery of 101.5 billion barrels, or 32.8 percent of the 309.9 billion barrels originally in the reservoirs. See **Page 47. Fluid Injection Boosts U. S. Reserves**.....**L. J. Logan**

☐ **Alaska may soon become the most active exploration area in U. S.,** now that statehood is a reality. Reasons for this prediction, including the most up-to-date report available on current drilling and leasing activity, plus a map outlining the 49th state's most promising oil areas, are presented in . . . **Statehood Spurs Alaska Oil Activity**.....**Page 49**

☐ **If the internal auditor is to be of value** to management, he must expand the audit function beyond the mere checking of accounting records. This problem, plus a complete analysis of the duties and management relationships demanded of the modern oil company auditor is discussed in detail by a top authority in auditing. Turn to **Page 54. Don't Overlook Internal Auditing**.....**Lon E. Teverbaugh**

Turn the Page ▸

What's in store for you in the August 15

International Outlook Issue

THE U. S. OIL INDUSTRY'S prospects now are brighter, following the past 12 months of slower activities and adjustment to the general business letdown.

The outlook has been improved . . .

In the first place by improvement of the general business picture, and

In the second place by successful efforts of the oil industry itself in balancing supply and demand and largely eliminating surplus stocks of crude and refined oils.

• • •

Complete details of this oil industry trend of improvement will be published in WORLD OIL'S **August 15 International Outlook Issue,** a special issue which furnishes annually world-wide trends, developments and forecasts to assist its readers in evaluating for themselves the future of their individual interests.

In addition to expectations for the U. S. petroleum industry in the last half of this year, comprehensive information on petroleum developments in all other countries where oil is sought and/or produced will be published in the International Outlook Issue.

• • •

- Will U. S. demand increase?

  Although exports have continued relatively low, the trend of U. S. domestic consumption has been improving gradually and promises to be good in the coming months. Extent of expected improvement will be indicated in the new revised forecast of demand for crude and products.

- How much more crude production?

  Benefiting from improving demand and from a rather sharp draw down of crude and product stocks, U. S. crude producers can hope for higher allowables and demand for more domestic production during the remainder of the year. WORLD OIL'S **mid-year forecasts** will give a good idea of the extent of production increases that can be expected.

- Will drilling expand and, if so, how much?

  With prospects good for substantial increases henceforth in crude oil production, U. S. operators are being encouraged to maintain or to expand drilling operations. Of course, there is no urgency since the present large producing ability exceeds current actual production. However, anticipated production gains will use some of the potential immediately, and even more will be used gradually as older wells decline in output.

  Consequently, producers must eventually drill new wells in greater numbers than recently. Some pickup in drilling logically can be expected. If and when the expansion will occur and its extent will be indicated in the International Outlook Issue.

• • •

Another International Outlook Issue "extra" is the annual revised forecast of U. S. drilling in the last half of 1958—which currently is being prepared. In making its revised forecast, WORLD OIL has asked for and is receiving the cooperation of oil companies that drill a high percentage of this country's wells. Present plans of these companies for drilling during the last half of 1958 will be reflected in this new forecast.

EXPLORATION ARTICLES

☐ **Many tests in Oklahoma,** which may have produced if drilled a few hundred feet deeper, have been abandoned because of poor correlation of the Wilcox sands of the Simpson group. This article and accompanying cross-sections summarize the various zones of the Simpson group. This correlation study is intended to provide better rock identification and to encourage the search for deeper structures. See **Page 71. Correlation of the Oklahoma "Wilcox"—an Aid in Finding Deeper Structures**.....**R. C. Tuttle**

☐ **An excellent example of seismic delineation of a buried fault** has been found in the South Louisiana area. This fault was correlated accurately with an electric log obtained from a well drilled in the field. The unusual accuracy of the seismic record section is illustrated on **Page 74. Buried Fault Indicated by Seismic Record Data**.....**Stanley M. Leventhal**

DRILLING ARTICLES

☐ **Protective casing was run** recently by Phillips Petroleum Company on its world's deepest well—University EE 1 in Pecos County, Texas. The success of this operation was attributed to the pre-planning of Phillips personnel and allied companies. Caution was exercised in every phase of the operation to minimize or eliminate all possible problems. Turn to **Page 79. Phillips Runs 22,919 Feet of Protective Casing.**

Jack F. Earl

☐ **Here is a nomograph that will help the mud man** in determining the amount of weighting agent of known density that must be added to a given volume of mud of a known weight to produce a mud of a required weight. Clip and save this nomograph on **Page 85. How Much Weighting Material to Add?**

P. W. Cooke

☐ **Preventive maintenance and proper handling of drill collars** are always of interest to the drilling contractor. Don't miss this pictorial presentation of various drill collar failures and their remedies. See Page 86. Have You Got Drill Collar Problems? Moak Rollins

☐ **Interested in a unique blowout preventer hookup** devised by one drilling company for use in its drilling operations? See BOP Hookup Uses Nitrogen as a Closing Medium.....Page 88

PRODUCTION ARTICLES

☐ **A multiple installation using four strings of 2⅜-inch O.D. tubing** has been successfully completed by the CATC Group in South Louisiana. A complete description of operating procedures used for the quadruple parallel string installation is presented in the article beginning on Page 90. CATC's Quadruple String Completion ..W. W. Poimboeuf and Robert Henderson

☐ **The Spraberry Trend may yet return a neat profit,** according to results of two water-flood projects and thorough research. Water-flooding may increase recovery as much as 1,500 barrels per acre. Estimated operating profits from such a project are $1.4 to $2 million per section. For a thorough discussion of Spraberry water-flood possibilities, see Page 94. Studies Indicate Spraberry Water-Flood Will Be Profitable.....L. F. Elkins

☐ **Predict reservoir behavior** and economic life of the reservoir with valuable information learned from a careful analysis of the gas-oil ratio curve. Read this second in a series of articles on reservoir engineering. Page 102. GOR History of a Depletion Drive Reservoir.....Frank W. Cole

☐ **Extensive studies of V-belt performance** now provide data which allow the engineer to develop new drive design methods and to predict relative belt service based on drive conditions and load that the belts will experience. Factors affecting V-belt service and horsepower capacity also are discussed. Annual V-belt drive costs can be calculated and increased operating efficiency obtained by applying this data. Turn to Page 103. Calculating Lowest Annual Costs for V-Belt Drives.....Robert A. Vandegrift

☐ **Causes, effects and methods of preventing ringworm corrosion** are presented in this timely article. Well maintenance costs can be reduced and tubing life extended by eliminating this "ghost" type of corrosion in upset tubing. See Page 112. Ringworm Corrosion in Upset Tubing..J. P. Engle and C. E. Fox

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Indexed by Industrial Arts Index and Engineering Index

Looking Ahead . . .

Will There Be Another Suez? **. . .** Answer to this question is loaded with "ifs". Biggest "if" at present is whether Mid-East situation will again whip Arab nationalism to fever pitch that resulted in blown up pipe lines and a blocked canal last year. Taking no chances, Interior Department is studying possibility of re-establishing previous Suez Committee, made up of U. S. oil men, as precautionary measure.

Also, suggestion is made that oil companies and state governments give early thought to more realistic cutbacks when next Mid-East crisis ends, should that area's crude again be cut off from the West. Independent producers, in particular, want no repeat of the problems they still face as result of last Mid-East upheaval.

Industry Outlook Varies **. . .** With total oil stocks holding steady for second month in a row, well under year ago levels, summer demand finally has eased tight allowable schedules. For August, Texas upped schedule from 9 to 11 days—Louisiana increased flow rates to 33 percent of March, 1953, from record low of 31 percent. Other states are following same pattern.

July rotary rig count wasn't so promising. U. S. rigs totaled 1,802 at mid-month, down 63 from week before. However, 1,865 rigs on July 7 resulted from 71-rig jump the previous week.

How Many "Spindletops" in Alaska? **. . .** Although less than 10 rigs are active in the 49th state at the moment, operators predict area will develop into one of the Western Hemisphere's largest oil provinces. (See Page 49). Oil companies and individuals have already invested $30 million in that prediction—out of $100 million earmarked for exploration work. Latter total is expected to triple within next few years.

Geological Survey says Alaska has 100 million acres geologically favorable to oil, with less than half that total properly mapped. Weather, transportation, supplies and distance pose immediate problems yet to be solved.

Record Holders Still Going Deeper **. . .** Great Western Drilling has set world's longest string of casing at the Phillips and Sinclair A-1 Montgomery in Pecos County, Texas. Seven-inch casing was set at 23,000 feet in preparation for testing the Ellenburger. This test, about 20 miles southwest of world's deepest hole, Phillips' EE 1, is now the second deepest hole ever drilled. EE 1 set 22,919 feet of combination string (7⅝ and 7-inch) in June.

At last report, EE 1 was drilling below 23,900 feet in Simpson formation, making 40-60 feet per day. Still trying to hit the Ellenburger.

Oklahoma's deepest well, Shell's Rumberger 5 in the Elk City field, was drilling below 21,000 feet, averaging about 50 feet per day.

Looking Ahead in Washington **. . .** Court has ruled against Eastern States' bid to bring temporary injunction against government's voluntary imports program . . .

Although the administration is against it, backers of Ikard bill are still trying to get it tacked on as amendment to proposed reciprocal trade program . . . *Twenty-nine oil companies indicted for price-fixing* have requested trial be switched from Virginia to Oklahoma, nearer home offices of principals involved . . . *Mid-East threat* has spurred Military Supply Agency to increase requests for avfuel.

Fluid injection boosts U. S. reserves

Secondary recovery methods will yield 13.1 billion barrels of oil and increase by 42.8 percent the 30.6 billion barrels of primary reserves.

By L. J. Logan
WORLD OIL Staff

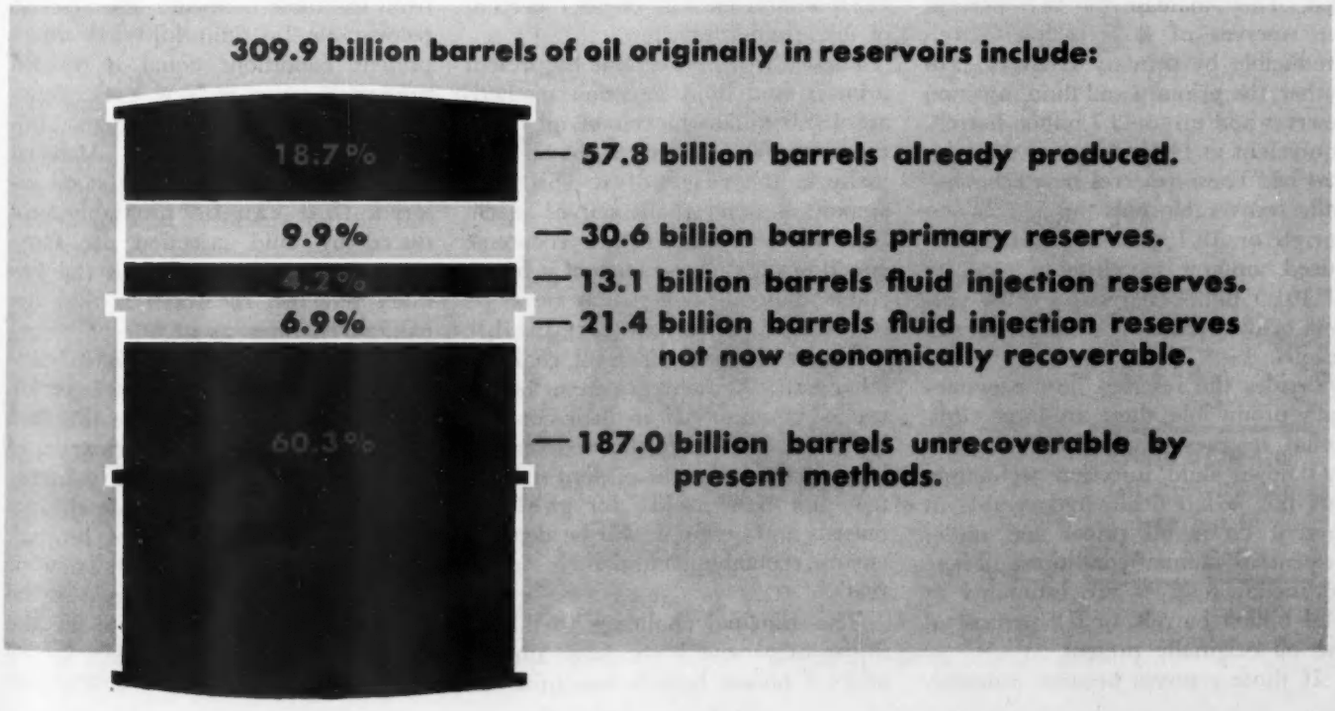
ALL OF THE oil fields ever found in the U. S. originally contained in their reservoirs 309.9 billion barrels. As of Jan. 1, 1958, they had already produced 57.8 billion barrels, or 18.7 percent of their original content. That left 252.1 billion barrels, or 81.3 percent, still in the ground.

What will become of this oil still in the reservoirs? What part of it will be recovered? What part of it can never be recovered by presently known methods?

Answers to these questions have been offered, along with the estimates of the amounts of oil originally in the reservoirs. The estimates have been prepared and published by the Interstate Oil Compact Commission's secondary recovery and pressure maintenance committee, of which Paul D. Torrey, Austin, Texas, is chairman. The committee's report was presented June 23, 1958, at IOCC's mid-year meeting at Salt Lake City, Utah. The table herewith, taken from the report, shows the salient data of the study. The accompanying chart has been designed by WORLD OIL to help visualize the findings of the committee.

As stated above, the reservoirs still hold 252.1 billion barrels, or 81.3 percent of the oil originally in them. Of this amount 30.6 billion barrels, equivalent to 9.9 percent of the orig-

Fluid Injection Reserves Are Important Part of U. S. Oil Resources


309.9 billion barrels of oil originally in reservoirs include:
18.7%
— 57.8 billion barrels already produced.
9.9%
— 30.6 billion barrels primary reserves.
4.2%
— 13.1 billion barrels fluid injection reserves.
6.9%
— 21.4 billion barrels fluid injection reserves not now economically recoverable.
60.3%
— 187.0 billion barrels unrecoverable by present methods.

Evaluation of United States Oil Resources as of January 1, 1958

All figures in millions of barrels of 42 U. S. Gallons

STATE	Estimation of Original Oil Content of Reservoirs	Total Oil Production to 1/1/58	1957 Oil Production API Figures	API Proved Reserves from Volume 12 (A) (1/1/58)	Percent of Proved Reserves Produced in 1957 (B)	Proved Primary Reserves as of 1/1/58	Reserves Recoverable by Known Fluid Injection Techniques	Reserves Recoverable by Fluid Injection Under Economic Conditions Existing at 1/1/58	Combined Primary and Fluid Injection Reserves	Percent of Combined Reserves Produced in 1957
New York	743	202	3	38	7.1	0	63	52	52	5.1
Pennsylvania	3,831	1,203	8	126	6.5	29	771	126	155	5.3
West Virginia	2,585	458	2	53	4.2	49	594	60	109	2.0
Kentucky	1,450	352	17	138	12.5	140	450	65	205	8.4
Ohio	4,500	649	6	68	8.1	65	185	7	72	7.7
Indiana	3,000	281	12	67	17.7	66	265	65	131	9.0
Illinois	7,211	1,996	76	655	11.6	356	3,250	1,200	1,556	4.9
Michigan	1,423	406	10	49	20.8	51	290	95	146	7.0
North Dakota	2,699	50	13	258	5.0	649	757	110	759	1.7
Nebraska	1,030	75	20	63	31.1	80	80	50	130	15.1
Kansas	14,700	2,959	124	948	13.0	850	325	100	950	13.0
Oklahoma	47,035	7,627	211	1,942	10.9	1,510	1,416	566	2,076	10.5
Arkansas	4,147	996	30	305	9.7	149	1,270	1,100	1,249	2.4
Alabama	358	18	6	34	18.7	58	118	98	156	4.1
Mississippi	3,107	546	37	360	10.3	407	1,032	86	493	7.5
Louisiana	22,423	4,333	298	3,858(C)	7.7	4,051	5,070	2,282	6,333	4.7
Texas	105,357	21,058	1,057	14,555(C)	7.2	15,210	10.236	4,856	20,066	5.3
New Mexico	8,000	1,178	92	832	11.1	1,094	2,288	500	1,594	5.8
Colorado	3,106	456	55	310	17.7	282	887	610	892	6.2
Wyoming	10,511	1,542	110	1,420	7.7	1,234	1,133	403	1,637	6.7
Montana	2,686	276	27	320	8.4	346	155	62	408	6.6
Utah	380	18	5	140	3.3	140	76(D)	28(D)	168	2.7
California	59,560	11,130	339	3,760(C)	9.0	3,760(C)	3,770	573	4,333	7.8
Other States (E)	65	9	1	4	18.2	4	2	1	5	13.0
Total	309,907	57,818	2,559	30,300	8.4	30,580	34,483	13,095	43,675	5.9
Change from 1/1/56	+21,384	+5,131	+140(F)	+288	....	+910	+1,653	+1,116	+2,026	+0.1

(A) American Petroleum Institute and American Gas Association, "Proved Reserves of Crude Oil, Natural Gas Liquids and Natural Gas, December 31, 1957, Volume 12".
(B) Calculated from actual production figures rather than abbreviated production figures.
(C) Includes off-shore reserves.
(D) Estimated by Paul D. Torrey; subject to future revision and correction.
(E) Includes Arizona, Florida, Missouri, Nevada, South Dakota, Tennessee, Virginia, and Washington. Revised June 8, 1958.
(F) Change from 1955 to 1957 production.

inal oil, are estimated primary reserves, recoverable by primary production methods.

In addition, 13.1 billion barrels, or 4.2 percent of the oil originally in place, are recoverable by fluid injection, under present economic conditions. These reserves are probably more important than is generally realized. They increase by 42.8 percent the reserves of 30.6 billion barrels producible by primary recovery. Together, the primary and fluid injection reserves add up to 43.7 billion barrels, equivalent to 14.1 percent of the original oil. These reserves now economically recoverable plus the 57.8 billion barrels or 18.7 percent already produced amount to ultimate recovery of 101.5 billion barrels, or 32.8 percent of the original content of the reservoirs.

Besides the reserves now economically producible, there are large additional reserves physically recoverable by known fluid injection techniques but not economically recoverable at present crude oil prices and under present economic conditions. Those additional reserves are estimated at 21.4 billion barrels, or 6.9 percent of the oil originally present.

If those reserves became economically as well as physically recoverable, they would boost to 34.5 billion barrels, or 11.1 percent of original oil, the total reserves recoverable by fluid injection. Those combined fluid injection reserves would exceed substantially the present 30.6 billion barrels of primary reserves. They would bring ultimate recovery up to 122.9 billion barrels, or 39.7 percent of the original oil.

Physically unrecoverable by present primary and fluid injection methods are 187.0 billion barrels of oil. That represents 60.3 percent of the oil originally in the reservoirs. This huge amount is now wholly out of reach. New methods and future economic conditions may make some of it recoverable. But much of it may never be recoverable. There are irreducible minimums beyond which oil, coal and other natural resources cannot be extracted profitably from their containing reservoirs. Also, the recovery of large quantities of the oil that remains may not be feasible for geologic reasons and certainly will be dependent on economic conditions in future years.

The principal challenge to the industry at present is the large amount of 21.4 billion barrels susceptible to recovery by fluid injection but not recoverable profitably under present economic conditions. The recovery of much of that oil is problematical at this time. But knowledge of its existence is important.

The important part that fluid injection will have in future oil production in various states is apparent from the table herewith. The reserves recoverable by fluid injection under present conditions equal or exceed primary reserves in New York, Pennsylvania, West Virginia, Indiana, Illinois, Michigan, Arkansas, Alabama and Colorado. In Illinois the oil reserves that can be profitably produced by fluid injection are more than three times as large as the primary reserves. In Arkansas they are over seven times as great.

The phenomenal growth in production of oil from fluid injection projects is the best evidence that can be presented on the significance of these operations, the IOCC committee chairman stated. Outside the actual discovery of oil reserves, he said, the development and application of fluid injecting techniques ranks as the most important single factor in the maintenance of the oil industry in any of the states. —**The End**

Statehood spurs Alaska oil activity

Of the state's 375 million acres (compared with Texas' 171 million), nearly one-third is geologically favorable for oil development.

ALL INDICATIONS point toward the 49th state becoming one of the busiest exploration areas in the U. S. Should one or more discoveries result from the several wildcats now reaching critical depth, Alaska's activity can be expected to increase at a still faster clip.

To date, 28 oil companies and several individuals have earmarked more than $100 million for exploration and development work. With more companies applying for leases, and statehood assured, some oil men are predicting expenditures will more than triple within two or three years.

At least 17 companies now have parties working in the field, according to the Alaska Department of Mines, and are using at least 51 helicopters in their exploratory work.

Some idea of the vast size of the potentially productive area involved, plus a clear indication of current and expected activity, can be gained from these Alaska Department of Mines figures:

- Out of the state's 375.3 million acres (compared with Texas' 171.1 million), nearly one-third, or about 110 million acres have been classified as geologically favorable for oil development.

- Of the favorable acreage, about 24 million acres are within the Navy's Petroleum Reserve No. 4 and another 2 million are in the Kenai Moose Range.

- Of the remaining 84 million acres available for development, about 30 million acres already have been leased.

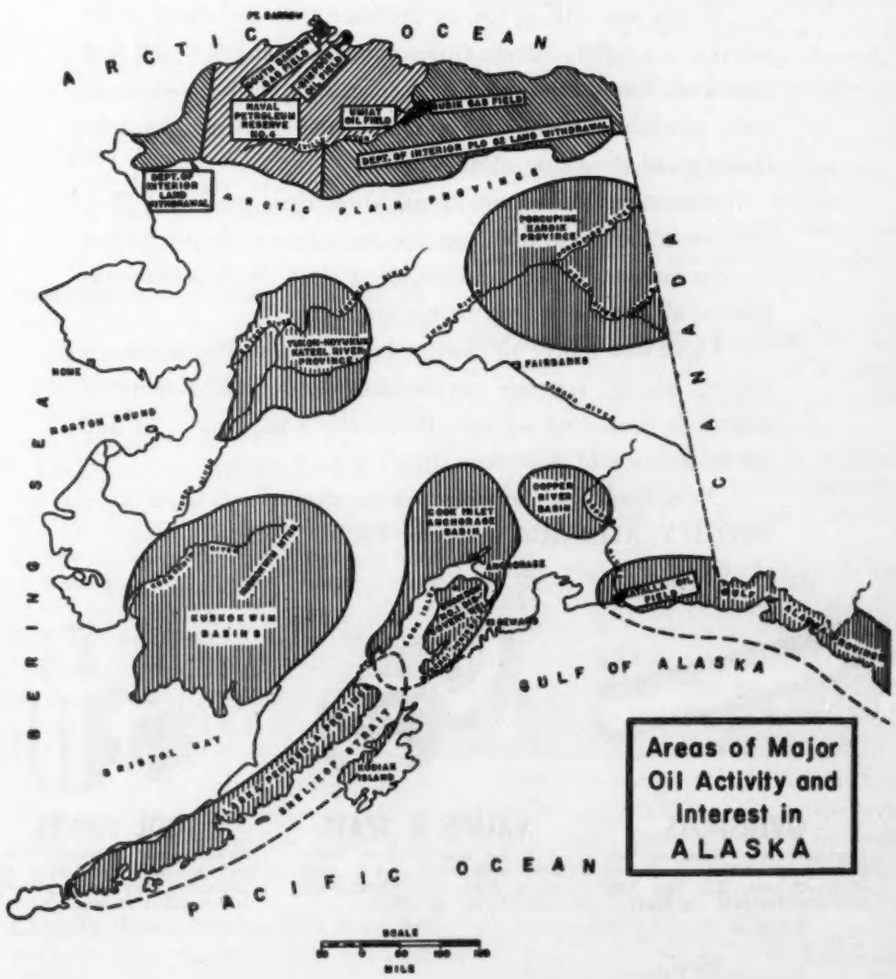
- At the present filing rate, about half of the remaining 54 million acres will be taken up within a year, and by 1960 probably all of favorable area will have been leased.

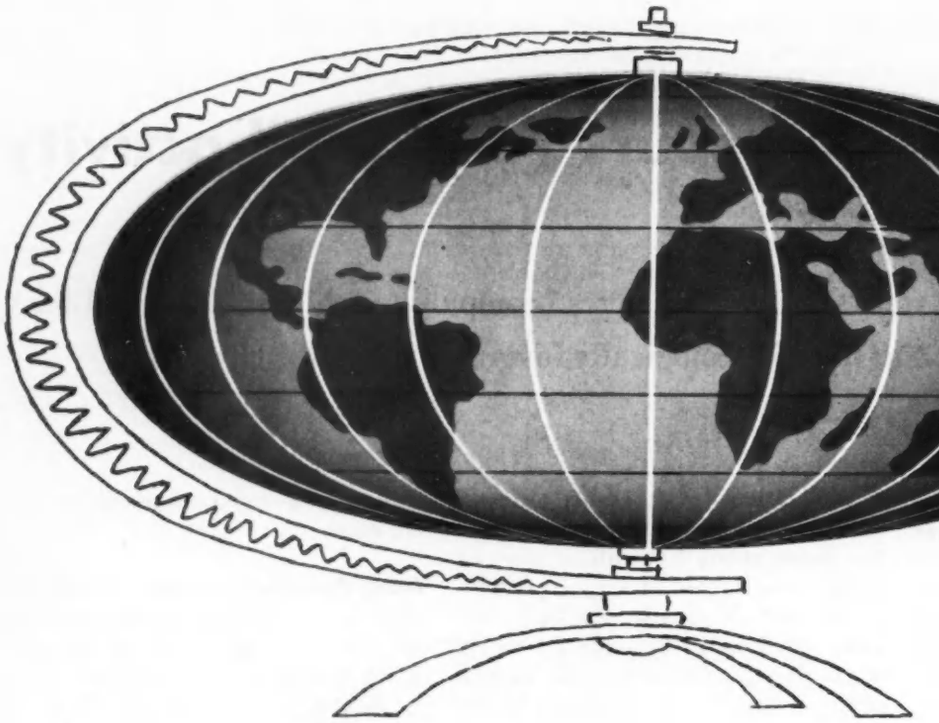
Mostly State Land. Under terms of the statehood bill, Alaska will be free to choose about 103 million acres of public land upon which to establish a tax base. Since the new state will have more than 20 years to choose the acreage, it will be possible to wait until oil actually is discovered before taking title.

As a result, oil men will be dealing largely with a state, instead of federal agencies. This, in turn, probably will result in more exploration and development work, brought about by easier leasing, more encouragement and less red tape.

Most Promising Areas. Alaska has eight areas considered favorable for oil. The sedimentary foothill provinces, according to one company active in Alaska, are similar and related to major oil areas in the Rocky Mountains and corresponding ranges in South America.

The central area, including the Porcupine-Kandik, Yukon-Koyukuk and Kateel River areas, is similar to the





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MANUFACTURERS OF OIL FIELD EQUIPMENT
OKLAHOMA CITY

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If you are drilling for, or producing oil anywhere in the world . . . jungles, deserts, frozen lands or swamps, you'll find American Iron Sales and Service representatives ready to make available to you the complete line of American Iron Drilling and Production Equipment.

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More and more, oil producers throughout the world are relying on the superior performance and dependability of American Iron Drilling and Producing Equipment . . . and the experience of American Iron's export agents.

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SPECIFY AMERICAN IRON PRODUCTS!

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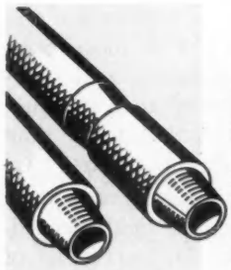
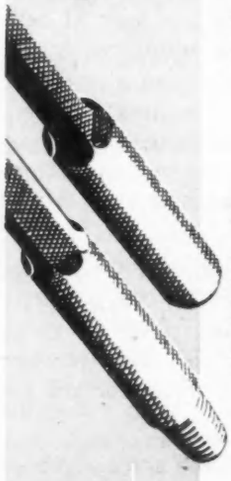


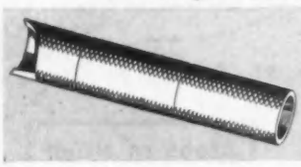
DRILL COLLARS

American Iron Premium Steel Drill Collars, with highest tensile and impact strengths, add longer life to your entire drill string. Regular or Rol-Flex with hand applied connectors.



KELLYS

For dependable rotation of your drilling string, American Iron Hex or square kellys are better balanced for smooth running at all drilling speeds.



OVERSHOTS

American Iron Releasing and Circulating Overshots are in worldwide use. The best hole insurance for your rig floor.

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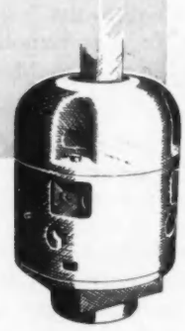
Built for high pressure operation, with 3-web seat for maximum fluid flow. Outlasts and outperforms all others.

TOOL JOINTS

Hand-applied "Straight Grip" tool joints, with 4-point seal protection, are easily removed and installed at your rig.



KELLY BUSHINGS

New Kelly Bushing pivoted-cage rollers are self-aligning with kelly, increasing life of all rotating parts. No adjustments, no shims needed for accurate fit at rig.

Another AMF Product
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inter-montane region between the Rocky Mountains and the Sierra Nevadas of California. The other areas are similarly attractive.

Current activity in Alaska is centered in the Kenai Peninsula, the Alaska Peninsula, southeastern Alaska, the Anchorage area, Cooper River Basin, the Kuskokwim, the Yukon-Koyukuk Kateel River area and the Porcupine-Kandik region.

Kenai Peninsula. Richfield Oil Company and Standard Oil Company of California have combined all their acreage on the peninsula, with Standard as operator. Standard is committed to spend $30 million developing the acreage.

Early in July, Standard was drilling and coring ahead below 13,750 feet in its Deep Creek Unit 1 near Ninilchik on the Kenai Peninsula some 50 miles southwest of the Richfield Swanson River Unit 1 wildcat completed in September, 1957, for 900 barrels per day of 30 gravity oil from nonmarine formations between 11,150 and 11,215 feet. This discovery was made even more significant by the subsequent drilling of a two-mile southerly offset which produced from the same pay. Both wells now are shut in temporarily until marketing arrangements are made.

Standard has not yet reported its findings in the Deep Creek Unit test.

In another deal, King Oil Company is committeed to spend $1.5 million to earn an interest in acreage held by Alaska Oil and Minerals Company south of the Richfield discoveries.

That exploratory work in the Kenai Moose Range will be stepped up is seen in the recent action of the Fish and Wildlife Service in granting permission to conduct geophysical work in that previously restricted area, providing work is done by helicopter.

Alaska Peninsula. In the Wide Bay area on the Alaska Peninsula, about 280 miles across Cook inlet southwest of the original Richfield discovery, Humble-Shell's Bear Creek Unit 1 wildcat reportedly has encountered some interesting shows farther up the hole. However, it was necessary to sidetrack a fish at 10,867 feet after a month-long try at recovering it. At the last report, re-drilling was in progress below whipstock set at 10,604 feet.

Humble is to drill three wells to earn a half interest in Shell's 250,000 acres in the area.

On Chinitna Bay, across the inlet from Kenai, Havenstrite Oil Company's Iniskin Unit 1 is being deepened from 9,975 feet and, farther to the south, Superior Oil Company reportedly is completing plans for a deep test later this year.

Several other companies and various individuals are conducting geophysical work throughout the peninsula.

Southeastern Alaska. Phillips Petroleum Company, after drilling three dry holes near Icy Bay, has announced no further plans although seven more wells have to be drilled under Phillips' agreement.

Colorado Oil and Gas Company has abandoned its Yukutat 1-A at 11,765 feet, but reportedly is planning a new location for drilling later this year.

Anchorage Area. Union Oil Company and The Ohio Oil Company are getting ready to drill on a joint block about 35 miles north of Anchorage, and Anchorage Oil and Gas is continuing with its test offsetting Union-Ohio to the north. Several drilling wells by small operators have been shut down for various reasons.

Copper River Basin. The Snowden interests are scheduling a test near Eureka, but no other activity apparently is planned although the basin is heavily leased.

Kuskokwim Province. Shell and others are planning geophysical and seismic parties for this year. Sunray-Mid-Continent also holds acreage in this area.

Yukon-Koyukuk-Kateel River. Another company reportedly is planning three wells following seismic work this year, although no announcements have been made.

Porcupine-Kandik Region. H. L. Hunt of Texas, who holds a large block, reportedly is planning six wells in the next two years. Other companies hold leases on about 3 million acres in the region, which extends into the Yukon Territory of Canada.

Japan May Buy Oil. Oil fields in Alaska would be the nearest source for Japan, a large importer. Governmental installations in the new state also represent a relatively large market, as does the U. S. West Coast region.

Despite common beliefs, Alaska has a comparatively warm climate and Bristol Bay, Kuskokwim Bay and Norton Sound are open for shipping throughout the year, making marketing by tanker entirely feasible.

—The End

Biggest Leaseholders in Alaska, With Net Acreage

Phillips Petroleum	1,000,000
Colorado Oil and Gas	600,000
Standard of California	450,000
Shell	300,000
Texota	190,000
Humble Oil and Refining	150,000
Sunray Mid-Continent	130,000
Alaska Oil and Minerals	126,000
Ohio Oil	125,000
Richfield	95,000
Socony Mobil	38,000
Erie Natural Gas	35,000

Good Wells Make Good News

A Special Report on Successful Cementing Jobs

August 1, 1958

CEALMENT* is a Dowell-developed cementing service that uses special latex-cement. This latex-cement has low fluid loss and good sealing characteristics. When set, it has demonstrated excellent resistance to shattering. These properties make possible results like those reported here.

- **Southern Saskatchewan, Canada.** A well in the South Alida Beds pool of the Nottingham field was making only 50 bopd and 50 bwpd. The formation—of the Mission Canyon series—was squeezed with 400 gallons of Dowell latex-cement. Final squeeze pressure was 2000 psi. *After re-perforating, well tested at a capacity rate of 300 bopd with negligible water. Six months later, capacity of well was unchanged; water production was negligible. Potential still exceeded production.*

- **Midland County, West Texas.** This well was to be completed with pay zones in Devonian and the Strawn. Since both zones might need stimulation, separation was necessary. A 5½-inch liner was set from 9963 to 11,545 feet using 2000 gallons Dowell latex-cement. *As a result, communication between zones was prevented.*

- **Baton Rouge Parish, Louisiana.** This well had a hole in the casing at 6940 feet, which was above the primary cement job. Cealment was selected to repair the hole. 800 gallons of latex-cement was squeezed using a pressure of only 100 psi. *After the remaining latex-cement was drilled out, casing held 1500 psi test pressure.*

- **Marion County, East Texas.** A well was completed through perforations into the Henderson sandstone from 6039 to 6044 feet. It was acidized but channelled to water. To repair the channel, Dowell used Cealment with 500 gallons of latex-cement. After squeezing, drilling out and re-perforating, well swabbed 36 bopd but would not flow. Dowell cleaned the formation with 500 gallons of lease oil containing two per cent Mudlax.* *After treatment, well flowed 72 bopd by heads, with no water. All three treatments paid out in less than 10 days of producing time.*

For detailed information on Cealment, or prompt service, call any of the 165 Dowell service points. In Canada, call Dowell of Canada, Ltd.; in Venezuela, contact United Oilwell Service. Or write Dowell, Tulsa 1, Oklahoma.

*Dowell Trademark

Services for the oil industry DOWELL

A SERVICE DIVISION OF THE DOW CHEMICAL COMPANY

Let's be thankful for an oil surplus

TODAY A BIG SURPLUS of oil exists in the Free World. It is possible to produce far greater quantities than are needed. Tomorrow, however, it may be difficult for the Free World to provide enough oil to fulfill all its needs. Such a drastic change could take place overnight.

This tremendously important and dangerous uncertainty hangs over the head of the oil industry of the Free World, and therefore also over the head of the military, industrial and civilian might of all Free World nations because of the current grave Middle East crisis.

No one can be sure we are not on the very brink of war, which would require tremendous quantities of oil. Even short of war, the accessibility of Middle East oil to the Western Powers is jeopardized by events of recent weeks in the Middle East.

ARAB NATIONALISTS at any moment can easily stop the movement of much of the Middle East's oil to Western powers. Particularly, easy to stop would be shipments made through pipe lines to the Mediterranean Sea.

Approximately 900,000 barrels of oil moves daily via pipe lines to the Mediterranean, 540,000 barrels from northern Iraq fields across Iraq, Syria and Lebanon, and an additional 360,000 barrels per day from Saudi Arabia across Syria and Lebanon. A handful of hot-headed Arab Nationalists, with or without the approval of their leaders, could easily blow up these pipe lines at will, as was done during the Suez Canal crisis.

If only that Middle East oil normally shipped by pipe line to the Mediterranean is shut off, Western powers would not experience much difficulty replacing it. At least a large part of the Saudi Arabia production now shipped by pipe line could be rerouted to move by tanker from Persian Gulf ports as long as the Suez Canal is open to Western tankers. The West could be deprived of production from northern Iraq if these pipe lines are blown up. Iraq oil must move overland. However, Western powers could easily replace this relatively small amount of producing from the surplus producing capacity in the U. S. and Venezuela.

Blowing up of the Iraq and Saudi Arabia pipe lines might prove more of a disadvantage to the Arab Nationalists than to the Western powers. Stoppage of Iraq production would deprive the Iraqi Nationalists of the country's principal source of income. Iraqi need for Western money may be greater than the West's need for Iraq oil.

IF THE SITUATION becomes more intense, and Western troops become involved in fighting, Nasser might decide to retaliate by closing the Suez Canal. This would deprive Western powers of most of the 4 million barrels of Middle East oil they are now consuming each day. Closing of the Suez Canal would impose a much more difficult situation on the Western powers. However, it would also pose difficult problems for Nasser.

Closing of the canal would create terrific financial burdens on Egypt. Canal tolls are one of the principal sources of revenue for the country. Approximately 1.8 to 2.0 million barrels of Middle East oil moves to market, principally in Western Europe, every day through the canal. Nasser also would be defying treaty obligations, and he might create the enmity of Saudi Arabia, Kuwait and Iran because he would be stopping their chief sources of income.

If the Suez Canal is closed to tankers, there would be an oil shortage in Western Europe, as there was in late 1956 and 1957 when the canal was closed. The U. S. and Venezuela again would be hard pressed to furnish enough oil to keep Western Europe plants in operation. Rationing again would be necessary in some Western Europe countries.

Come what may, the U. S. oil industry again, as many times before, stands ready to place a considerable surplus producing capacity at the disposal of the nation and its Allies. Thanks to the stimulus provided by this country's competitive business system, a sizable surplus producing capacity once again has been developed in the U. S. during the past decade. Let's be thankful this country has a surplus of oil. It may come in very handy—soon.

Warren L. Baker

Don't overlook internal auditing

The internal auditor's value to management can be increased manifold if his function is expanded beyond the mere checking of accounting records.

By Lon E. Teverbaugh
Continental Oil Company, Ponca City, Okla.

PRESENT DAY concepts in internal auditing have very little resemblance to internal auditing as practiced 12 to 15 years ago.

To function properly in today's operations, the internal auditor must have his independence. The status of the internal auditor should be clearly defined in the organization charts of the company. It should indicate the support accorded the auditor by management and will be the determining factor of the range and value of the services which management will obtain from the auditing function.

The head of the internal auditing department should report to an officer of sufficient rank in the organization to assure an effective scope of operations and adequate consideration and action on the findings or recommendations made by him.

Internal Control Is Major Factor. The devising and installing of procedures which are essentially a part of the regular operations of a complete and adequate accounting system or of a properly organized operating department should not be the responsibility of the internal auditing department. Since complete objectivity is basic to the audit function, internal auditors should not prepare records, or engage in other activities which at a later date they will be expected to review and appraise.

One of the major items on the audit program today is "Internal Control." Too frequently the auditor looks at internal control only from the viewpoint of accounting and record keeping. It is applicable to all departments of the company as it has its origin in the organizational set-up of the company and flows down through all levels of management.

The policy guide, general authority limitations, departmental delegations of authorities and policy and procedure guides are definitely a part of the internal control of the company. The checking of policies, authority limitations and plans and procedures as outlined by management is a part of the function of the internal auditor.

Operating in a field of broad perspective, in which the operations of all parts of the company are included, he is in a favorable position to note aspects of policy or method which might be significant in savings or better methods. He can be an effective liaison agent. The interpretation and administration of policy in large organizations must necessarily be left to the various levels of authority within the company.

In the course of making any such review of internal control, it becomes necessary, of course, to understand a large number of the operating and technical problems of business management, to see that the department heads are exercising normal good business judgment and are carrying out the over-all policies laid down by the management.

By such an approach an indirect entry into the audit of operating and technical subjects is effected without considering it as purely a technical audit of the subject itself. It enables the auditor to look at the subject from the over-all standpoint of good business judgment, rather than from a purely technical standpoint. The results of audits of this kind should be of considerable help in selling management on the value of complete audits of operating and technical departments.

Compliance With Policy. Another function of the internal auditor, and one that is quite different from that of the external auditor, is that he must ascertain the degree of compliance or lack of compliance with established company policies, plans and procedures. This requires complete familiarity with regulations, instructions, and procedures, as well as sufficient experience to determine whether such regulations require revision due to changed conditions or for other reasons.

Check Performance and Work. The check of performance and/or correctness of work is another feature of the audit program and is one that will probably require the largest part of the time of the auditor. This consists of verifying the accuracy of reports, whether accounting or operating, and verifying that the company's assets and liabilities have been correctly accounted for. This phase of the audit is similar to that of the public accountant. Therefore, the audit program of both groups can and should be co-ordinated—they should complement each other but should not duplicate.

Verifying Company Assets and Liabilities. The program must provide ways and means of verifying that all of the company's assets as shown by the records are on hand and that the entires affecting the accounts have been properly made. It is necessary, therefore, not only to determine the physical existence of the assets

but also that they are actually worth what the books reflect.

The auditor's examination must also determine that the proper accounting has been made of all liabilities of the company. This means that he should ascertain that the liabilities have been properly stated, that those shown by the records are legitimate debts of the company, and that payments have been made to the proper persons.

This is only a start, however. He must go further and determine that the liability incurred was necessary, that it was authorized only after receiving assurance that it was necessary, that it was incurred with the company or person which could furnish the most value for the expenditure, that full value was received and, finally, that the liability was correctly recorded and paid.

Determine Company Income. Another important phase of the audit, and one very difficult to accomplish, is to determine that all income to which the company is entitled has been received and accounted for properly. This function of the audit requires a knowledge of all phases of the company's activities. It also requires a review and study of all reports rendered, as well as visits to operations to determine sources of income and whether regular or infrequent.

Contracts and agreements should be carefully reviewed as they are frequently sources of revenues not controlled by regular routines. Finally, curiosity in discussing operations and asking questions concerning various phases of the business may develop many new leads in tracking down unrecorded income.

Open Discussion Is A "Must." The entire audit program must be well thought out, well organized and agreeable to management. To secure acceptance by divisional or departmental heads in connection with the audit, the auditor should discuss his findings with all concerned before the report is written.

It is generally a good idea to include the comments of the person being audited in the report, as this can avoid later back-tracking and extra work by him.

What Management Wants from the Internal Auditor

Management looks to the internal auditor for concise and well written reports which record:

1. Full factual disclosure of exceptions to a company's policies and procedures.

2. The views of the department head under audit concerning such exceptions.

3. The remedial action taken or contemplated that is acceptable to both the auditor and the department head.

4. The respective recommendations of both the auditor and the department head when their views cannot be reconciled, or when the determination of policy on a higher level is necessary.

Remedial action should be suggested but under no circumstances should the corrective action be attempted by the auditor—it is someone else's duty to carry that out.

Suggestions by the auditor for reducing expenses and increasing profits is one of the most fertile fields for recognition of auditors by management, as they produce really tangible results when accepted. It might be well to mention that this is also the phase of internal auditing which causes most auditors to "stub their toes." Ideas and suggestions not thoroughly practical and carefully thought out can be very distasteful to management.

"Inside" and "Outside" Cooperation. Another phase of auditing which should be given careful consideration is the coordination of the audit function by the outside auditor and the internal auditor.

Proper coordination of the work of the two groups for the benefit of management involves compliance with certain important principles:

1. Each group must retain its own separate identity and maintain a clear-cut line of demarcation in responsibility.
2. The outside auditor cannot commit himself in advance as to what accounts, activities or period he will review or to what extent his tests will be undertaken.
3. The outside auditor is charged with the requirement of making tests as to the efficiency of the work done by the internal auditor as a proper basis for reliance on such work.

The outside auditor has no right to expect that accounting and auditing methods, practices and theories which he may have and which are suitable for his purposes will either be employed or endorsed by management and by the internal auditor. He does have a right to know clearly and definitely just what policies and procedures are prescribed and followed so that he can adapt his own work accordingly.

If he attempts to impose his ideas upon management or the internal auditor, or conversely, if the outside auditor's pertinent suggestions are not considered, the result will be harmful to all.

Mutual cooperation, with complete understanding of the duties and obligations of the other, will result in many benefits to management and in a smooth working relationship between all parties concerned.

—The End

Here's the most modern hook-wall packer yet!

Product No. 420-E

The NEW BAKER Model "E" RETRIEVABLE CASING PACKER

Drawing on the experience and know-how gained from 30 years of leadership in the field of design and development of high-performance retrievable squeeze tools, BAKER has combined many of the features from these tools with the simplicity of J-Slot operation to make possible this short, most modern of all hook-wall packers.

Only three feet long, the Model "E" Retrievable Casing Packer has the same rocker-type slips and proven dependable packing element used so successfully on BAKER retrievable squeeze tools. No drag springs to make a long, cumbersome tool. No slip tie-links or guide grooves to allow the slips to become stuck or cocked. No restricted bore to prevent running instruments through the packer.

Easy to run (just rotate to the right and set down) and easy to retrieve (just pick up the tubing) the BAKER Model "E" Retrievable Casing Packer is a model of high-performance in a small package.

See your BAKER man today for additional information on how the BAKER Model "E" Retrievable Casing Packer can solve your hook-wall packer needs.

BAKER

BAKER OIL TOOLS, INC.

HOUSTON • LOS ANGELES • NEW YORK

How to get a bank loan

DOZENS OF OIL MEN, caught by the tightening profit margin squeeze, are visiting their bankers to discuss short-term loans. Many of these requests for emergency operating capital will be turned down.

Is there anything you can do to improve your credit standing at a time when lenders are taking a sharp look at loan applications. Is there a way you can be sure of needed financing when bankers are refusing others?

There is. And the first step is to understand how your banker goes about sizing you up as a credit risk.

The five "C's". The information your banker obtains will be sifted and studied to see how you stack up against five different tests—the so-called five C's.

First, your banker will want to know about your *character* and *capacity*. Are you a dependable businessman and reputable citizen in the community? Too, he will check the information supplied by your references and your record of repayment of previous loans. And you can be sure that your capacity for achievement as a businessman will be carefully evaluated. If you don't pass these personal tests, the other three C's make little difference.

Capital comes next. Inexperienced businessmen often expect the bank to provide the lion's share of their financial backing. You probably will not get very far with your loan application unless you are willing to back your own confidence with a personal investment in reasonable proportion to your existing and proposed debt.

Collateral, bankers say, does not make a bad loan good, but it may make a good loan better. Banks do not like to foreclose; they are less interested in the price of your inventory, real estate or other assets might bring in a forced sale than they are in your normal ability to repay.

Conditions refer to the influence of business trends in general and the tightness or easiness of credit. Of course, your banker will know a great deal about the economic climate of your community and will be interested in your prospects in relation to it.

For unsecured loans of $10,000 and up, the tendency in banking circles today is to require an audit by a certified public accountant. Take your CPA with you when you go to the bank to discuss the loan. Then, if an audit is necessary, you, your banker and your CPA can agree on the information to be submitted.

Beware of attempting to restrict the scope of an audit. The audit is made so the CPA can express an opinion on your financial statements. If you limit the extent of his investigations, he may be forced to disclaim an opinion on the fairness of your statements. Bankers prefer to receive "clean certificates," ones which have been certified with no qualifications.

Keep proper financial records. Bankers know that the majority of business failures—and bad loan risks—are caused by a failure to keep adequate financial records and install business-like accounting systems. It eases a creditor's mind to know that a CPA will be advising you on cost controls and telling you how to avoid unnecessary scrapes with the tax collector—another factor which bears on your credit standing.

Five Ways to Check Your Credit Rating

When a banker analyzes your financial statements, he is assessing your economic health. Here are some of the ratios or standards which he uses—and which you can calculate yourself—to determine your chances of getting a bank loan:

Current Ratio . . . Current assets divided by current liabilities; should be at least 2 to 1, but special circumstances sometimes are considered.

Quick Assets to Current Debt . . . Cash, receivables and other ready cash items divided by current debt; 1 to 1 is the rule-of-thumb, but this, too, is flexible.

Debt to Capital . . . Money owed to creditors compared to owner's money in the business; the lower the ratio the better.

Fixed Assets to Capital . . . Real estate, buildings, fixtures divided by net assets; ratio should be kept low as possible to avoid depleting working capital.

Inventory to Working Capital . . . Shows percentage of working capital tied up in inventory; abnormally high ratio may result in shortage of liquid working capital to meet other expenses.

PARKERSBURG DAU*

WELSORBERS AND WELDRIERS

Put Your Problem to Parkersburg's Engineering Know-How to show you where to locate a DAU Welsorber or Weldrier and give you an accurate picture of distillate recovery possibilities.*

**Dynamic Adsorption Units, a Parkersburg Original (Patented).*

PARKERSBURG ORIGINATED AND STILL LEADS IN DEHYDRATION-HYDROCARBON RECOVERY UNITS

1 Parkersburg originated unitized short cycle Dehydration-Hydrocarbon Adsorption Units in 1952.

2 The *only complete line* of Dehydration-Hydrocarbon Adsorption Units. Dehydration capacities from 1 million to 100 million standard cubic feet per day. Distillate recovery capacities from 7.5 Bbls/Day to 135 Bbls/Day stable stock tank oil.

3 Parkersburg units are ready to go *on-stream* when they are delivered to location. *No costly extra accessories are needed. No field insulation of towers is required.*

4 Parkersburg has trained technical personnel in all Production Equipment Division Branch offices capable of installing and operating DAU Welsorbers and Weldriers. No factory "experts" have to be flown in to iron out experimental "bugs".

5 Parkersburg DAU Units have been proven by six years of rugged testing and field service.

6 Parkersburg DAU Units are self-contained, with all necessary controls for completely automatic, unattended operation anywhere, regardless of location. No external source of energy is required. No shutdowns due to electrical and other power failures.

Factual Comparison

of the Parkersburg DAU with similar equipment now on the market.

		Parkersburg	Unit X	Unit XX*
1	How many short cycle dehydration—hydrocarbon adsorption units are built and in operation?	72	3	1
2	How many years have these units been in operation in the field?	5½	1½	½**
3	How many different models of units are advertised as being available?	27	2	1**
4	Is power pump required for the operation of the unit?	NO	YES	YES
5	Is the unit complete with inlet separator as part of the "package"?	YES	NO	NO
6	Are any units operating on offshore platforms?	YES	NO	NO
7	Are any units operating in sub-zero climates?	YES	NO	NO
8	Are any units operating on hot compressor discharge gas?	YES	NO	NO
9	Are any units processing full wellstreams, serving as separation, dehydration, AND hydrocarbon recovery equipment?	YES	NO	NO
10	Are any units "riding" gas pipelines, serving as dehydration and hydrocarbon recovery equipment?	YES	YES	YES**

*Conventional Unit, converted to short cycle for experimentation
**Experimental Unit

You can put your problem to PARKERSBURG'S ENGINEERING KNOW-HOW . . . the same know-how that originated and still leads in dehydration-hydrocarbon recovery units.

THE PARKERSBURG RIG & REEL COMPANY
Division of Parkersburg-Aetna Corp.
PRODUCTION EQUIPMENT DIVISION OFFICES: P. O. BOX 13295, HOUSTON 19, TEXAS

By **Warren L. Baker,** Editorial Director

Higher U. S. producing rates in prospect

Substantially larger producing rates are ahead for U. S. producers, as excessive inventories are eliminated by large drafts on stocks during recent months.

U. S. oil producers can look forward to substantially higher producing rates during the remainder of 1958. The first move in this direction took place in July, with an additional gain already assured by August allowables. Further ahead will be additional boosts in U. S. crude oil producing rates.

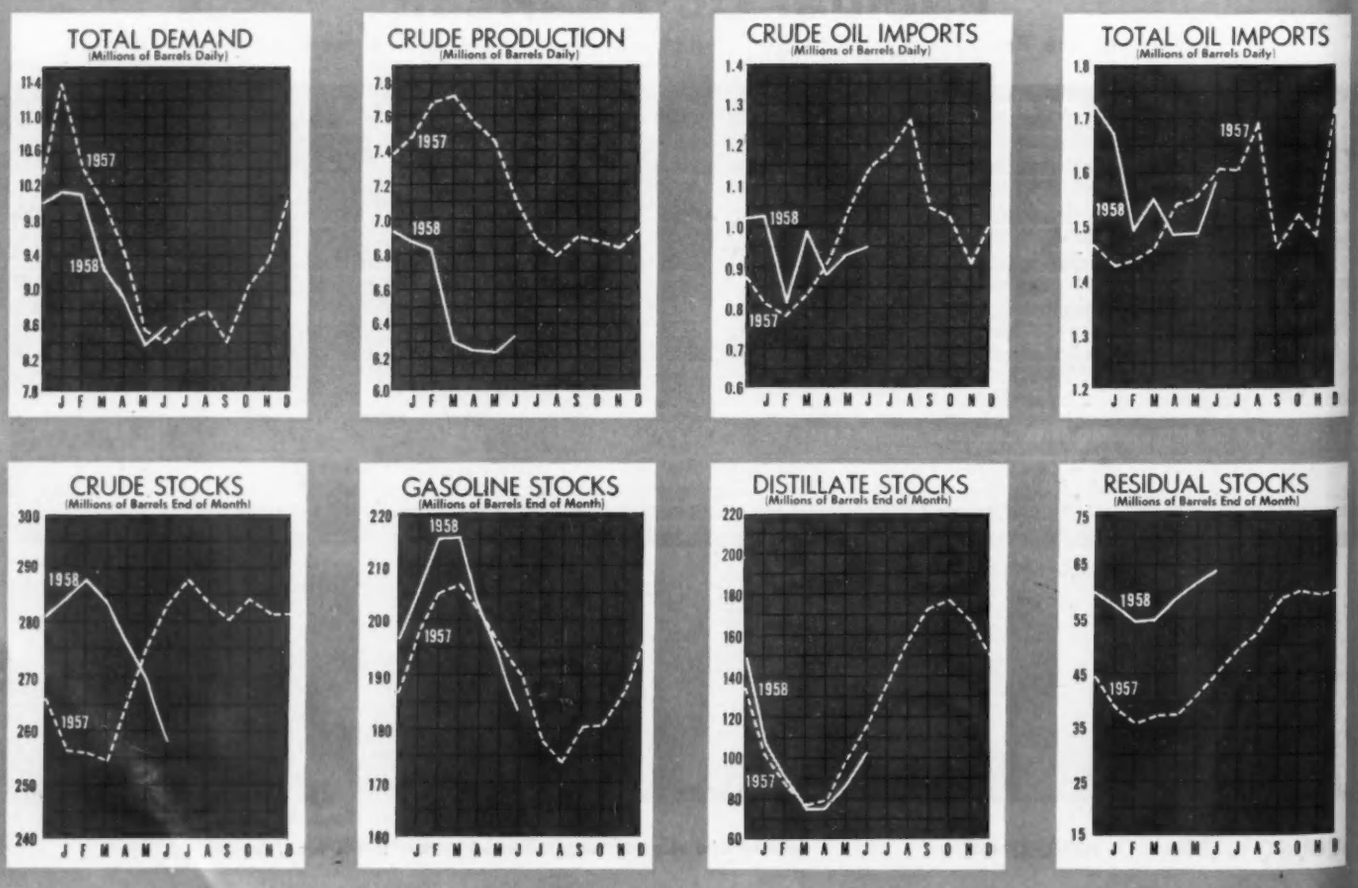
U. S. crude oil production may be as much as 1 million barrels per day larger by December, 1958, than in the spring months of 1958, when it averaged only 6⅓ million barrels daily. Chances are good that production in the closing months of 1958 will exceed rates which existed during the last three months of 1957.

Correction of excessive inventories is the principal factor which will tend to bring producers relief from exceptionally low producing levels during spring months.

An unprecedentedly large reduction in U. S. oil inventories has occurred in recent months. Drastic cuts in production and refinery output of products, coupled with the government's restrictions checking the growth of imports, have been responsible.

More than 20 million barrels have been taken from crude oil stocks since the end of March. The inventories now are 24 million barrels less than

Petroleum Trends...



a year ago, whereas they had been nearly 24 million barrels greater on March 31. All the reduction has taken place outside California.

Gasoline inventories in mid-July were identical with 12 months before, although they had been 12 million barrels greater on March 31. Practically all the change has taken place outside of California. Current inventories of motor fuel are 36 million barrels less than at the end of March.

Distillate fuel oil inventories are 40 million barrels less than on January 1. At their mid-July level they were 16 million barrels less than at the corresponding period of 1957, although they had been 21 million barrels larger than the previous year at the end of January.

Residual fuel oil inventories are 19 million barrels above year ago levels. However, only 2 million barrels of this gain has taken place outside of California.

The outlook is further brightened by improving demand. The industry can look forward to a seasonal increase in consuming rates. Oil consumption always is at its lowest levels in spring months, and then climbs steadily month by month to seasonal peaks during winter months.

Furthermore, domestic oil consuming rates are showing signs of improvement. Domestic consumption has exceeded the corresponding period of 1957 during the last two months. Consequently, prospects are that consumption during the last half of 1958 will be somewhat larger than during 1957.

Producers no longer need to hold new supply below current consuming rates, now that stocks are not excessive. This factor alone presages higher producing rates in coming months.

Indicated August production rates will be about 400,000 barrels per day higher than in June. Most of the gain will come from Texas, which will be producing 11 days in August compared with only 8 in April, May and June.

Texas' production in August likely will average slightly more than 2½ million barrels daily. This would be one-quarter of a million barrels greater than in June of this year, and but one-quarter of a million barrels below August, 1957, volumes.

U. S. Monthly Oil Trends

(THOUSANDS OF BARRELS DAILY)

	JUNE			May	JANUARY-JUNE		
	1958	1957	% Diff.	1958	1958	1957	% Diff.
U.S. Crude Oil Production	6,335	7,107	—10.9	6,245	6,465	7,493	—13.7
U.S. Nat. Gas Liquids Prod.	750	775	— 3.2	780	787	818	— 4.7
U.S. Total Imports	1,580	1,606	— 1.6	1,484	1,598	1,505	+ 6.2
East Coast Crude Imports	700	872	—19.7	753	764	689	+10.9
Total Crude Imports	950	1,147	—17.2	936	938	920	+ 2.0
Total Refined Products	630	459	+37.3	467	646	584	+10.6
Total New Supply	8,666	9,488	— 8.7	8,510	8,850	9,816	— 9.9
Stock Changes All Oils (Daily)	+70	+1,091	.....	+129	—403	+122	.....
Total Demand All U.S. Oils	8,596	8,397	+ 2.4	8,380	9,254	9,695	— 4.6
Gasoline Demand	4,182	4,156	+ 0.6	4,075	3,813	3,878	— 1.7
Distillate Fuel Demand	1,153	1,150	+ 0.3	1,100	1,928	2,008	— 4.0
Residual Fuel Demand	1,232	1,366	— 9.8	1,150	1,503	1,720	—12.6
Domestic Demand, All Oils	8,346	7,952	+ 5.0	8,155	8,998	8,929	+ 0.8
Export Demand, All Oils	250	444	—43.7	225	256	766	—66.6
Crude Runs U.S. Refineries	7,578	7,867	— 3.7	7,397	7,117	8,002	—11.1
Domestic Crude Runs	6,601	6,757	— 2.3	6,491	6,537	7,102	— 8.0
Foreign Crude Runs	977	1,109	—11.9	906	921	900	+ 2.3

	TOTAL U.S. STOCKS Millions of Barrels End of Month				STOCKS EAST OF CALIFORNIA Millions of Barrels End of Month			
	June			May	June			May
	1958	1957	% Diff.	1958	1958	1957	% Diff.	1958
Crude Oil	257.3	284.3	— 9.5	268.8	212.4	251.4	—15.5	224.3
Gasoline	184.7	190.1	— 2.9	193.3	158.7	163.1	— 2.7	166.3
Distillate Fuel Oil	105.2	117.4	—10.4	89.3	92.1	104.6	—12.0	81.8
Residual Fuel Oil	64.3	37.8	+70.1	61.8	32.1	30.2	+ 6.3	30.7
Kerosine	24.2	28.9	—16.3	21.7	23.8	28.5	—16.5	21.3

Source: Except for latest two months, all data from U.S. Bureau of Mines. Data for last two months from American Petroleum Institute weekly reports and U.S. Bureau of Mines weekly crude stock report; except U.S. Natural Gas Liquids Production and Demand figures which are estimated by World Oil.

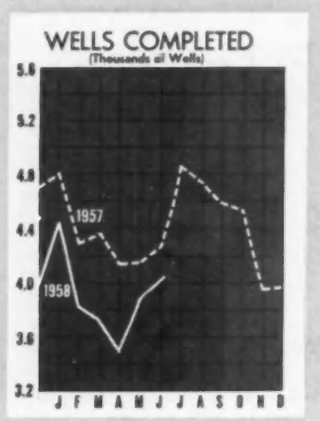
U. S. Crude Production by States

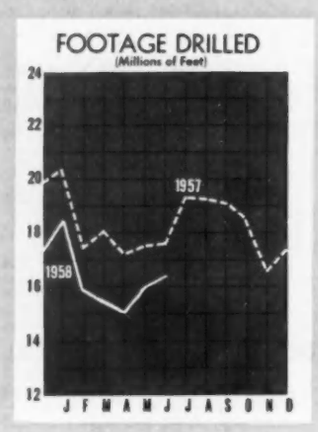
(THOUSANDS OF BARRELS)

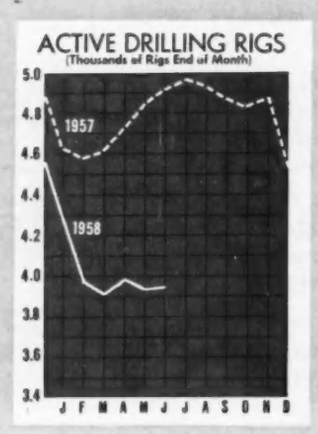
	DAILY AVERAGE PRODUCTION				TOTAL PRODUCTION		
	June			May	January-June		
STATE or DISTRICT	1958	1957	% Diff.	1958	1958	1957	% Diff.
Alabama	15.9	16.3	— 2.5	14.9	2,867	2,520	+ 13.8
Arkansas	75.4	82.8	— 8.9	79.6	14,491	15,392	— 5.9
California	850.1	925.0	— 8.1	855.2	158,007	168,614	— 6.3
Colorado	132.1	146.6	— 9.9	136.3	24,667	28,015	— 12.0
Florida	1.3	1.2	+ 8.3	1.1	223	228	— 2.2
Illinois	227.2	175.5	+ 29.5	219.2	40,464	38,265	+ 5.7
Indiana	31.5	34.8	— 9.5	29.5	5,704	6,556	— 13.0
Kansas	322.1	333.3	— 3.4	321.4	57,306	60,046	— 4.6
Kentucky	43.3	45.5	— 4.8	42.0	7,776	8,378	— 7.2
Louisiana	813.4	829.9	— 2.0	814.3	149,223	173,861	— 14.2
North Louisiana	112.6	128.3	— 12.2	115.9	20,603	24,523	— 16.0
South Louisiana	700.8	701.7	— 0.1	698.4	128,620	149,338	— 13.9
Michigan	25.0	27.4	— 8.8	25.6	4,609	5,124	— 10.1
Mississippi	97.8	107.8	— 9.3	102.2	17,983	20,492	— 12.3
Missouri-Tennessee-South Dakota	0.3	0.2	+ 50.0	0.3	63	45	+ 40.0
Montana	78.4	75.7	+ 3.6	73.9	13,719	13,081	+ 4.9
Nebraska	54.2	50.2	+ 8.0	52.3	9,559	9,024	+ 5.9
Nevada	0.1	0.1	.....	0.1	17	15	+ 13.3
New Mexico	283.4	248.4	+ 14.1	274.2	47,924	47,291	+ 1.3
Southeast New Mexico	248.4	242.8	+ 2.3	246.7	44,896	46,211	— 2.9
Northwest New Mexico	35.0	5.6	+525.0	27.5	3,028	1,080	+180.4
New York	5.8	7.2	— 19.5	6.8	1,160	1,345	— 13.8
North Dakota	38.4	40.0	— 4.0	35.4	7,045	7,158	— 1.6
Ohio	17.5	13.8	+ 26.8	17.4	3,120	2,487	+ 25.5
Oklahoma	534.3	547.4	— 2.4	545.8	99,196	110,898	— 10.6
Pennsylvania	17.9	22.6	— 20.8	19.2	3,416	4,177	— 18.2
Texas	2,278.7	3,083.3	— 26.1	2,203.1	438,954	577,616	— 24.0
Dist. 1: South Central	45.8	53.9	— 15.0	45.5	8,322	10,186	— 18.3
Dist. 2: Middle Gulf	98.7	150.9	— 34.6	95.9	19,663	28,900	— 32.0
Dist. 3: Upper Gulf	347.0	457.5	— 24.2	346.7	66,686	84,510	— 21.1
Dist. 4: Lower Gulf	171.8	233.2	— 26.3	160.6	32,341	44,077	— 26.6
Dist. 5: East Central	25.9	40.0	— 35.3	25.6	5,254	7,524	— 30.2
Dist. 6: Northeast	220.1	338.6	— 35.0	214.4	43,993	64,136	— 31.4
Dist. 7-B: North Central	122.4	165.9	— 26.2	122.4	24,079	30,204	— 20.3
Dist. 7-C: West Central	121.4	164.5	— 26.2	114.1	23,011	31,300	— 26.5
Dist. 8: West	826.0	1,160.7	— 28.8	779.4	156,955	214,170	— 26.7
Dist. 9: North	193.2	212.7	— 9.2	191.8	35,169	38,771	— 9.3
Dist. 10: Panhandle	106.4	102.6	+ 3.7	106.8	19,332	18,961	+ 2.0
Utah	83.1	8.8	+844.3	69.5	7,109	1,803	+294.3
Virginia	.....	.....	.....	.....	2	3	— 33.3
Washington	.....	.....	.....	.....	5	.....	.....
West Virginia	6.2	5.8	+ 6.9	6.2	1,090	1,074	+ 1.5
Wyoming	301.9	277.1	+ 8.9	300.0	54,524	52,814	+ 3.2

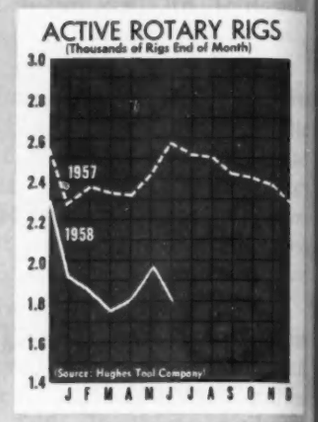
Source: Bureau of Mines and API. Texas Districts from API and do not necessarily agree with State Totals.

Drilling Activities...









U. S. drilling rates record another gain during June

Third consecutive monthly advance pushes new well completions to 4,129, not far below '57 volumes.

U. S. DRILLING rates are recovering much of the ground they have lost during the past year. Drilling activity increased again in June. New wells drilled rose for the third consecutive month, reaching the highest level since January and only 155 below June, 1957, rates.

A total of 4,129 new wells was completed during June. This compared with 3,910 during May, 3,553 in April, and 3,672 during March.

Wells completed in June represented the drilling of 16.4 million feet of hole, in contrast with 16.1 million feet in May, 15.0 million feet in April, and 15.5 million feet in March.

The increase in drilling activity during June over preceding months was widespread. Of the 25 states recording well completions in June, 17 had a higher drilling rate than in May.

Well completions in June exceeded those in June, 1957, in eight states. These were Colorado, Indiana, Mississippi, Missouri, New York, North Dakota, Oklahoma and West Virginia.

Additional growth in well completion rates is indicated by an increase in rigs currently in operation. At the end of June, 3,943 rotary and cable tool rigs were in use. This was in contrast with 3,886 at the end of May. Thirteen states had more rigs operating at the end of June than at the close of May. These were Colorado, Georgia, Indiana, Kansas, Mississippi, Montana, North Dakota, Ohio, Oklahoma, Texas, Utah, West Virginia and Wyoming.

The first six months of 1958 have seen the drilling of only 23,250 wells, 10.8 percent less than the 26,076 drilled during the first half of 1957. Footage has declined even more sharply. The 96.5 million feet drilled in the first six months of 1958 being 11.1 percent below the 108.5 million feet drilled during the corresponding period of 1958.

Favorable prospects for higher producing rates (Page 64) presage an increased volume of drilling during the last half of the year. Increased production will provide both additional funds and an incentive for boosting drilling. WORLD OIL's mid-year forecast of drilling activity, covering the next six months, will be published in the August 15 issue.

Details on completions, footage drilled, rigs in operation, and number of wildcats drilled by states appear in the table on Page 68.

Summary of U. S. Drilling Activity

ITEM	June 1958	May 1958	SIX MONTHS January-June 1958	1957	% Dif.
New Wells Completed:					
Oil	1,991	1,938	11,693	13,804	— 15.3
Distillate	43	71	386	323	+ 19.5
Gas	370	307	1,957	1,780	+ 9.9
Service	125	133	660	494	+ 33.6
Dry	1,600	1,461	8,554	9,675	— 11.6
Total Wells	4,129	3,910	23,250	26,076	— 10.8
Footage Drilled (Mln. of Feet)	16.4	16.1	96.5	108.5	— 11.1

Summary of U. S. Wildcat Drilling

ITEM	June 1958	May 1958	SIX MONTHS January-June 1958	1957	% Dif.
New Field Discoveries:					
Oil	65	67	375	399	— 6.0
Distillate	6	9	51	64	— 20.3
Gas	13	22	115	115	.....
Total Discoveries	84	98	541	578	— 6.4
Dry Wildcats	734	596	4,100	4,966	— 17.4
Total Wildcats	818	694	4,641	5,544	— 16.3
Percent Productive	10.3	14.1	11.7	10.4	.....
Percent Dry	89.7	85.9	88.3	89.6	.....

(Details on Page 68)

Eliminate Bulky, Costly

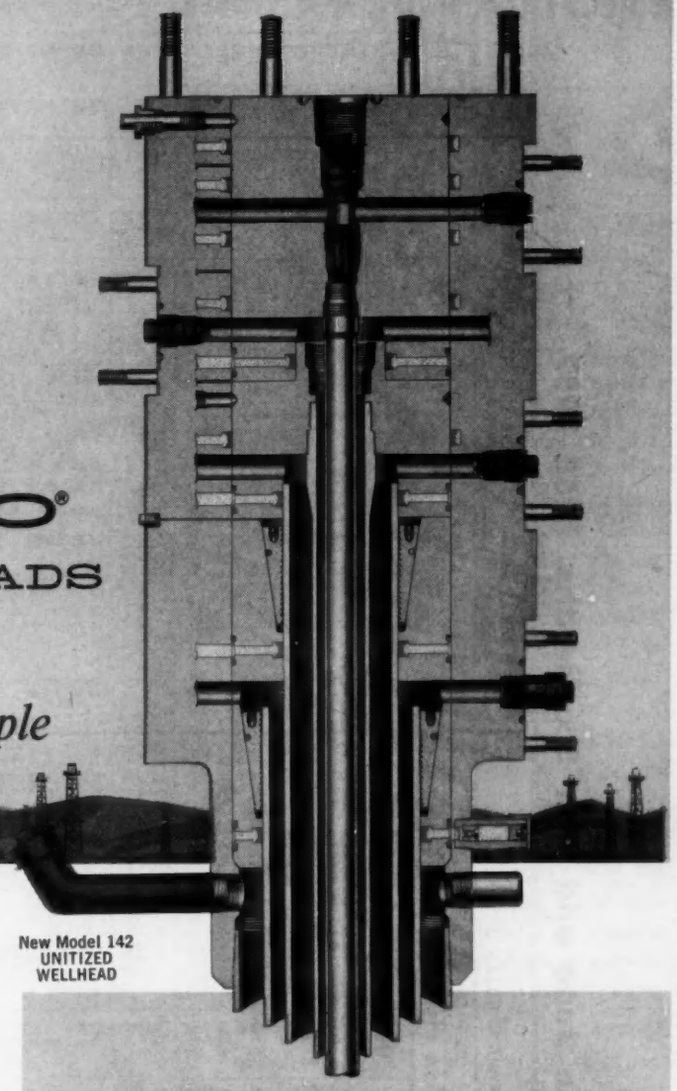
Christmas Trees

with COSASCO®

UNITIZED WELLHEADS

employing advanced

Access Fitting principle



New Model 142 UNITIZED WELLHEAD

ASK THE MAN who's used one. Cosasco one-piece forged steel wellheads employing the advanced Access Fitting principle are more compact, economical and far safer than conventional Christmas tree installations.

ADVANTAGES OF UNITIZED WELLHEADS

VALVES ELIMINATED. Use of Cosasco Access Fittings eliminates bulky, expensive and hard-to-operate valves from flow lines. Wellhead dimensions are reduced to a minimum, while safe access to tubing and annulus is easier and faster than with conventional equipment.

COMPLETE BLOWOUT PROTECTION. With the Cosasco Unitized Wellhead, blowout prevention equipment need not be removed at any time during drilling and completion programs. Tubing is *positively blocked* during final completion. Standby time for flanging up wellhead connections is eliminated... and the entire hookup, including high-pressure flow lines and separators, can be tested for leaks *before* the well is put on production.

ADAPTABLE TO ANY WELL. Cosasco Wellheads are available for all casing programs, all A.P.I. series and pressure ratings to 30,000 psi. Thirty-two different methods of landing tubing are offered, including dual and triple string hangers. Solid mandrels or two-piece, annulus instrument study Kobe type, gas lift stripper, polish joint wrap-around, and injection arrangements can be furnished. All Cosasco Wellheads are available with female-thread-down, male-thread-down or slip-on-and-weld connections to casing.

FREE CATALOG. Write today for new 32-page illustrated Catalog covering Cosasco's complete line of Access Fittings and Unitized Wellheads.

NEW COSASCO WELLHEAD SERVICE TESTED FOR 30,000 psi WORKING PRESSURE!

NOW COSASCO INTRODUCES the most compact, highest-pressure wellhead ever built—the Model 142 Unitized Wellhead. Through use of the advanced Cosasco Access Fitting principle, the Model 142 lands *four* strings of casing plus the production tubing... yet is only *55"* high over-all. It is actually service tested for *30,000* psi working pressure.

STEP-BY-STEP SAFETY CHECK. As each string is landed in the Cosasco Wellhead, the operator can test all fittings for leaks before proceeding with the next operation. Back-pressuring of intermediate casing strings to protect production casing and tubing from high-pressure collapse can then be done with complete safety.

ONE PIECE FORGED STEEL UNIT. Body of the Model 142 is hammer-forged from one billet of alloy steel. All stainless-steel construction (Gr. 303) is optional at moderate additional cost for off-shore submerged installation.

WELLHEAD ENGINEERING SERVICE

Discuss your wellhead problems with your Cosasco Field Man ...or write to Cosasco. We will furnish drawings, specifications and quotations—at no cost to you.

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PERFECT CIRCLE CORPORATION

11655 McBEAN DRIVE, EL MONTE, CALIFORNIA

Export Office: 3631 Atlantic Blvd., Long Beach 7, California

U. S. Drilling Activity in June and First Six Months, 1958-1957

STATE or DISTRICT	TOTAL NEW WELLS COMPLETED AND FOOTAGE DRILLED: DETAILS FOR JUNE, 1958					TOTAL NEW WELLS			Total Footage June, 1958	DETAILS FOR JANUARY-JUNE: NEW WELLS			DETAILS FOR JANUARY-JUNE: FOOTAGE		WILDCAT DRILLING IN JUNE AND FIRST SIX MONTHS, 1958-1957: DETAILS FOR JUNE, 1958					DETAILS FOR JANUARY-JUNE					DRILLING RIGS IN OPERATION (Rigging up, Drilling, Temp. Shut-Down)		
	Oil	Dist.	Gas	Dry	Service Wells	June 1958	May 1958	June 1957		1958	1957	Percent Diff.	1958	1957	Oil	Dist.	Gas	Dry	Total Wildcats	Oil	Dist.	Gas	Dry	TOTAL WILDCATS 1958	TOTAL WILDCATS 1957	June 30 1958	May 31 1958	June 30 1957
Alabama	5	....	....	2	....	7	6	11	58,961	38	62	— 38.8	332,308	544,737	....	....	....	2	2	....	....	....	13	13	22	7	10	11
Arkansas	23	....	3	41	....	67	62	115	239,012	330	507	— 35.0	1,145,162	1,503,967	1	....	1	15	17	6	....	6	70	82	73	39	66	82
California	75	....	6	27	....	108	118	190	509,679	748	1,089	— 31.4	3,491,688	4,691,790	1	....	....	14	15	4	....	1	112	117	181	127	136	184
Colorado	9	....	2	70	....	81	60	73	412,925	381	402	— 5.3	1,999,836	2,096,170	....	....	....	49	49	15	....	5	177	197	246	58	54	59
Florida	....	....	....	....	....	....	....	....	.....	2	6	— 66.7	18,942	40,312	....	....	....	....	....	....	....	....	2	2	6	1	1	1
Georgia	....	....	....	....	....	....	....	....	.....	....	3	—100.0	.....	18,955	....	....	....	....	....	....	....	....	....	....	3	1	....	1
Illinois	68	....	1	129	1	199	191	229	493,946	1,018	1,187	— 14.2	2,338,978	2,655,090	1	....	....	37	38	2	....	....	256	258	354	265	268	254
Indiana	34	....	....	50	....	84	59	50	135,116	337	323	+ 4.3	545,996	507,302	....	....	....	24	24	2	....	1	87	90	87	109	95	106
Kansas	156	....	13	161	8	338	324	356	1,167,416	1,683	2,023	— 16.9	5,784,067	7,206,396	11	....	2	84	97	60	....	13	379	452	478	455	379	584
Kentucky	58	....	12	80	2	152	109	165	207,989	661	744	— 11.2	939,355	1,114,985	1	....	....	1	2	3	....	1	26	30	59	102	109	123
Louisiana	136	14	36	107	....	293	269	335	2,259,378	1,655	1,790	— 7.6	13,648,584	14,867,058	1	1	1	43	46	19	10	4	226	259	289	338	349	396
North Louisiana	45	....	25	42	....	112	82	123	447,862	560	622	— 10.0	2,172,046	2,321,280	1	....	....	11	12	7	....	....	53	60	77	79	93	68
South Louisiana	91	14	11	65	....	181	187	212	1,811,516	1,095	1,168	— 6.3	11,476,538	12,545,778	....	1	1	32	34	12	10	4	173	199	212	259	256	328
*Gulf of Mexico	32	....	1	8	....	41	44	72	367,668	259	348	— 25.6	2,467,367	3,270,605	....	....	....	4	4	3	1	....	19	23	40	50	50	94
Michigan	13	....	15	....	....	28	45	30	85,445	179	192	— 6.8	521,394	551,416	1	....	1	11	13	3	....	2	54	59	80	68	73	77
Mississippi	11	....	2	15	....	28	19	20	268,013	177	178	— 0.6	1,566,164	1,212,851	....	....	....	11	11	5	1	....	73	79	95	51	46	39
Missouri	1	....	1	....	....	2	....	....	1,951	8	1	+700.0	5,206	370	....	....	....	....	....	....	....	....	1	1	2	1	1	1
Montana	14	....	1	15	....	30	26	46	178,040	161	178	— 9.6	915,302	957,469	....	....	1	13	14	3	1	4	61	69	55	36	35	52
Nebraska	32	....	....	51	1	84	60	84	490,305	315	423	— 25.6	1,868,922	2,499,749	5	....	....	32	37	17	....	....	130	147	220	29	40	49
Nevada	....	....	....	....	....	....	....	....	.....	....	3	—100.0	.....	5,718	....	....	....	....	....	....	....	....	....	....	3	1	1	1
New Mexico	99	....	45	32	....	176	125	190	835,298	969	1,116	— 13.2	4,632,855	5,092,215	6	....	1	17	24	22	2	13	103	140	146	177	199	186
Southeast	69	....	....	18	....	87	76	104	436,412	511	709	— 28.0	2,580,314	3,419,088	5	....	....	11	16	16	2	4	60	82	95	73	75	96
Northwest	30	....	45	14	....	89	49	86	398,886	458	407	+ 12.5	2,052,541	1,673,127	1	....	1	6	8	6	....	9	43	58	51	104	124	90
New York	21	....	1	2	24	48	48	39	73,800	288	231	+ 24.6	442,800	394,100	....	....	....	....	....	....	....	....	....	....	....	28	33	58
North Dakota	13	....	....	15	....	28	35	18	188,740	196	132	+ 48.4	1,340,037	920,677	1	....	....	10	11	15	....	....	44	59	56	38	36	28
Ohio	50	....	23	17	....	90	74	96	226,552	481	469	+ 2.5	1,240,571	1,151,762	....	....	....	....	....	....	....	....	3	3	3	228	218	215
Oklahoma	389	6	33	257	58	743	589	361	2,156,409	3,649	2,809	+ 29.9	11,464,007	10,272,372	5	1	1	74	81	32	6	16	324	378	314	455	447	564
Pennsylvania	19	....	32	7	7	65	98	76	239,980	284	448	— 36.6	640,488	1,289,086	....	....	....	....	....	....	....	....	....	....	25	98	99	172
South Dakota	....	....	....	....	....	....	....	2	.....	3	25	— 88.0	16,991	95,533	....	....	....	....	....	....	....	....	3	3	24	1	1	1
Texas	710	23	100	482	24	1,339	1,476	1,639	5,624,215	8,751	11,011	— 20.6	37,780,369	46,022,793	30	4	3	279	316	161	31	40	1,817	2,049	2,556	950	935	1,354
Dist. 1: South Central	38	....	5	48	....	91	80	94	196,885	516	696	— 25.9	1,267,704	1,743,345	2	....	....	37	39	9	1	1	184	195	196	34	31	47
Dist. 2: Middle Gulf	11	4	1	19	....	35	76	62	222,580	361	363	— 0.6	2,184,604	2,276,055	....	....	....	8	8	6	6	6	86	104	131	27	26	45
Dist. 3: Upper Gulf	25	7	10	59	....	101	122	136	724,502	667	876	— 23.9	4,250,034	5,933,451	2	....	1	34	37	5	3	5	164	177	235	68	75	129
*Gulf of Mexico	....	....	....	3	....	3	2	....	25,069	8	5	+ 60.0	62,356	37,935	....	....	....	3	3	....	....	1	5	6	3	2	2	....
Dist. 4: Lower Gulf-S.W.	29	6	6	47	....	88	123	117	439,147	609	720	— 15.5	3,123,131	3,807,170	2	1	1	33	37	12	9	3	221	245	224	61	63	87
*Gulf of Mexico	....	....	....	2	....	2	....	2	18,005	6	10	— 40.0	67,064	95,721	....	....	....	1	1	....	....	....	2	2	....	....	2	3
Dist. 5: East Central	3	....	....	17	....	20	13	11	66,093	85	78	+ 8.9	318,511	347,122	....	....	....	14	14	2	1	....	48	51	58	14	10	8
Dist. 6: Northeast	32	4	6	23	....	65	71	90	362,023	427	546	— 21.8	2,272,402	2,988,969	1	1	....	15	17	4	2	2	103	111	126	58	61	74
Dist. 7-B: North Central	86	....	2	85	3	176	177	171	569,993	1,060	1,331	— 20.4	3,468,804	4,526,123	13	....	....	53	66	41	3	5	331	380	478	68	70	121
Dist. 7-C: West Central	25	....	6	34	6	71	52	95	320,816	407	621	— 34.5	2,074,793	2,716,614	2	....	....	19	21	19	....	3	101	123	203	59	60	95
Dist. 8: West	266	1	4	50	3	324	388	379	1,556,076	2,148	2,521	— 14.8	10,482,246	12,310,404	6	1	....	31	38	34	1	4	221	260	249	308	292	390
Dist. 9: North	146	....	11	84	12	253	278	365	690,528	1,826	2,560	— 28.7	5,449,134	6,606,850	1	....	....	30	31	21	2	4	308	335	593	174	158	241
Dist. 10: Panhandle	49	1	49	16	....	115	96	119	475,572	645	699	— 7.8	2,889,006	2,766,690	1	1	1	5	8	8	3	7	50	68	63	79	89	117
Utah	14	....	1	9	....	24	27	25	139,239	222	92	+141.3	1,249,239	541,169	....	....	....	5	5	....	....	....	41	41	47	43	34	54
Washington	....	....	....	....	....	....	....	1	.....	4	2	+100.0	20,794	12,003	....	....	....	....	....	....	....	....	3	3	2	....	....	1
West Virginia	17	....	40	9	....	66	44	57	179,035	378	284	+ 33.1	970,878	778,738	....	....	2	1	3	....	....	6	4	10	10	150	135	175
Wyoming	24	....	3	20	....	47	44	75	239,550	323	344	— 6.2	1,514,550	1,473,976	1	....	....	10	11	6	....	2	83	91	106	83	79	96
Others	....	....	....	2	....	2	3	1	3,107	9	2	+350.0	29,359	12,673	....	....	....	2	2	....	....	1	8	9	2	4	7	6
Total United States	1,991	43	370	1,600	125	4,129	3,910	4,284	16,414,101	23,250	26,076	— 10.8	96,464,842	108,531,432	65	6	13	734	818	375	51	115	4,100	4,641	5,544	3,943	3,886	4,930
Total Western Canada	108	....	5	51	13	177	160	359	775,942	1,070	1,456	— 26.6	5,807,458	6,876,323	....	....	....	....	....	....	....	....	....	....	....	213	215	219

* Gulf of Mexico wells are included in their respective district total.

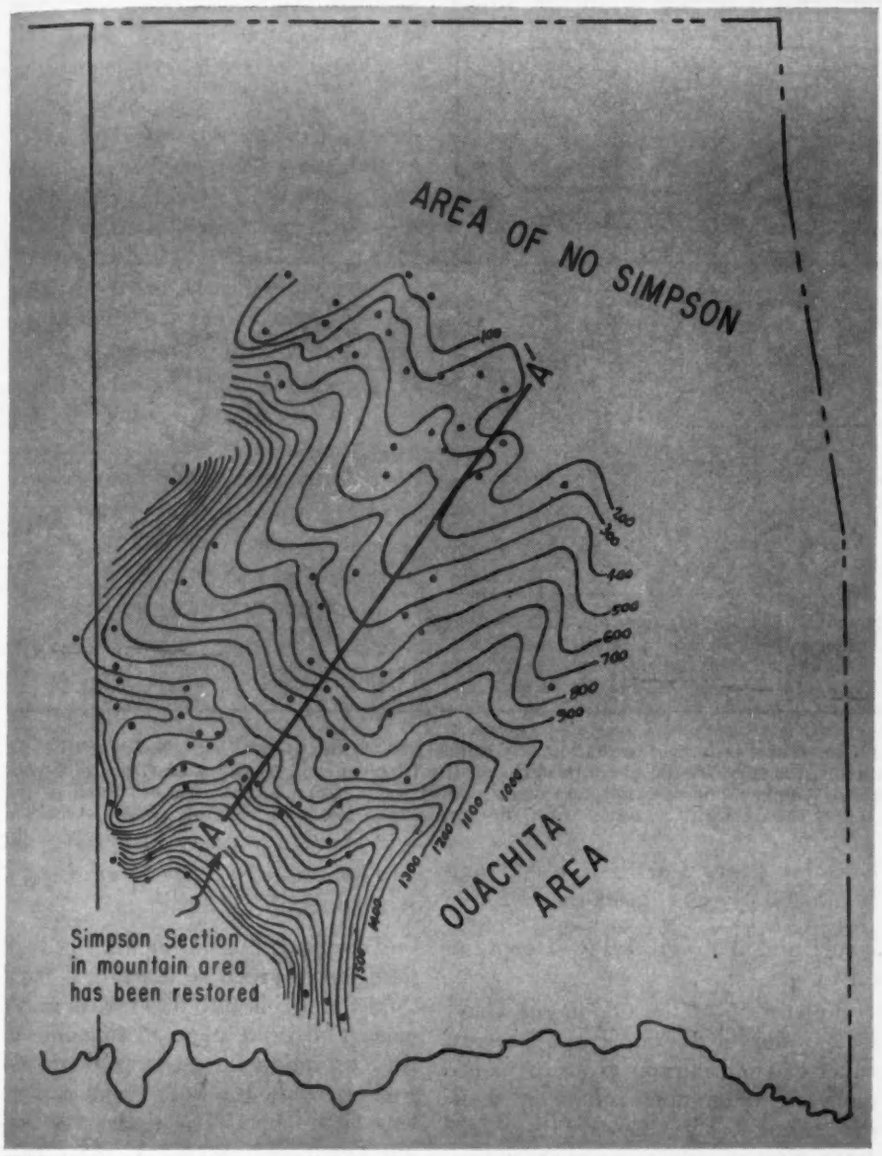


FIGURE 1—An outline map of the eastern part of Oklahoma showing the thickness of the Simpson-Viola groups in 100-foot intervals. Note the approximate position of the electric log cross-section A-A' (Figure 2).

Correlation of the . . .

Oklahoma "Wilcox"—an aid in finding deeper structures

Better identification of rocks will help geologists and operators in seeking new fields.

By R. C. Tuttle, Consulting Geologist, Tulsa

RESERVOIR POSSIBILITIES appear very good below the Bromide sandstones of the Simpson Group (Wilcox) in eastern Oklahoma, as demonstrated by recent developments in McClain and Cleveland counties. Many other areas of eastern Oklahoma—Osage, Tulsa, Muskogee and other counties where the lower beds of this group are present—have had little exploration in these zones.

Sizable oil reservoirs have been found in the Hominy and Burgen sandstones of the lower Simpson Group and, in addition, there are many pools in this area which produce from the Arbuckle. The Oconee field in Coal County has large proven reserves in the McLish and Oil Creek zones. The number of tests in the Greater Seminole area which have been drilled through the so-called Second Wilcox are negligible. This same statement can be made for most of eastern Oklahoma.

It can be seen that in such a large and virtually untested area many deeper structures must remain which will afford accumulations of oil and gas. Many of these not only will increase reserves substantially but also will prove profitable to the operators. The comparatively shallow depths (less than 4,000 feet and comparable to depths in excess of 5,000 feet in southern and western Oklahoma) and high recoveries will allow a larger return on investment.

Most engineers allow double recoveries from the Simpson Group over Pennsylvanian beds because of excellent porosity, permeabilities, sorting, cleanness and heavy water drive of the average Wilcox sandstone. Operators in the area under discussion can receive a larger return on their investment because the additional drilling necessary to test all of the Simpson section usually is less than 1,000 feet, if the test is bottomed in the first sandstone under the Viola limestone. If oil is found in any of the lower Simpson (Wilcox) sands, the operator may expect something nearer 600 barrels per acre foot recovery than the 240 barrels per acre foot in most Pennsylvanian sandstones.

On finding water in the First or Second Wilcox sand, most operators abandon the well. But is this a wise decision for a test which originally

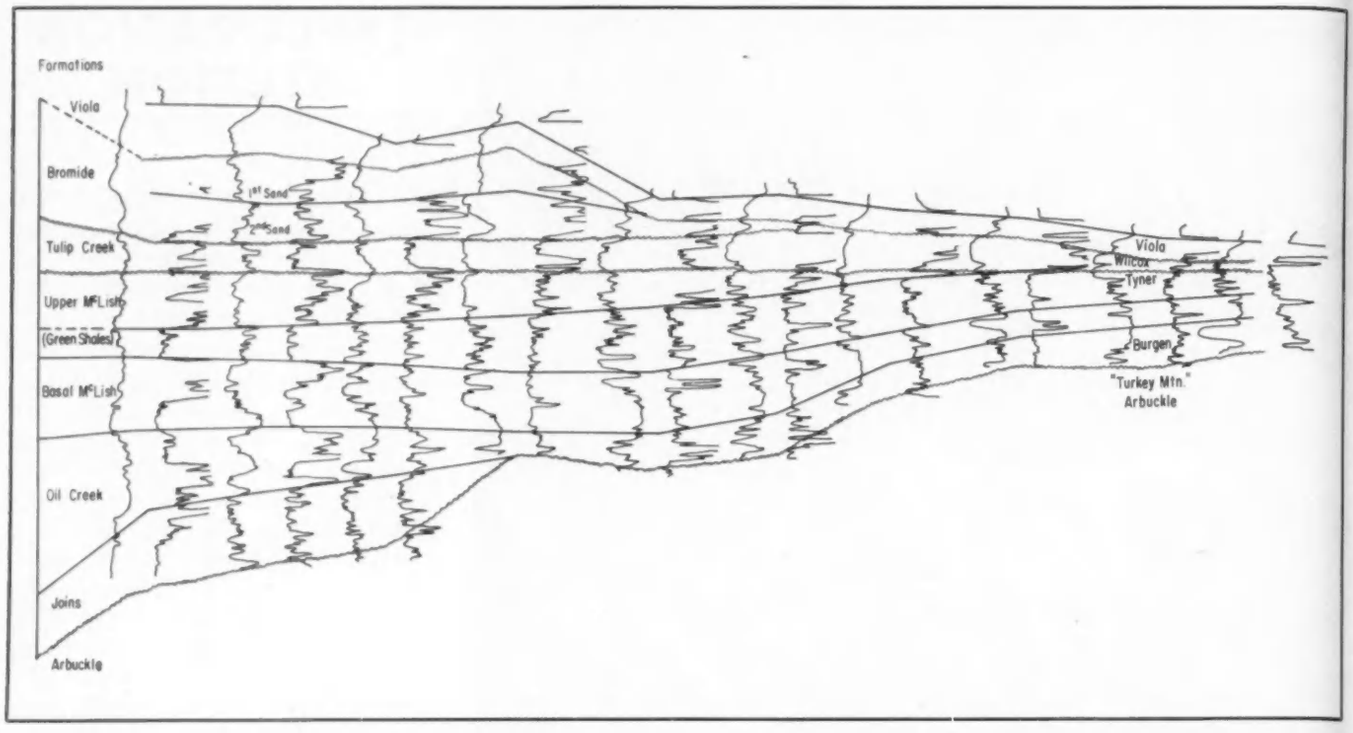


FIGURE 2—Electric Log Cross-Section A-A', no horizontal scale. A general northeast-southwest cross-section, starting in the Arbuckle Mountains and extending northeastward to Wagoner and Muskogee counties, is drawn from a plane on top of the McLish formation. By using this datum plane, it is believed that the disconformities in the Chazyan and Mohawkian stages of deposition are more readily seen. Correlations can be noted of the zones from the top of the Viola to the top of the Arbuckle.

was located with some merit? Unless the test was low structurally, should it be abandoned before testing all known reserves? The 400 to 800 feet of additional drilling required to test the lower formations can never be done any cheaper than before abandonment.

Instead of plugging the well, the operator should first re-evaluate the geology of the prospect. A careful re-examination of all the available electric logs will make this second evaluation of the geology somewhat easier.

In Oklahoma, the reservoir performance of the Simpson Group Wilcox sands is well known. However, correlating the many names for oil-bearing zones in this group is confusing to many operators and geologists. It is believed that a correlations of the Simpson Group zones, taken from their outcrops in the Arbuckle mountains in South Central Oklahoma, to the area where the so-called Wilcox sands were first named in northeastern Oklahoma will have some value, both as to a better identification of rocks and as an aid in seeking new reservoir beds within the group. It can help explain why an upper sand in the Simpson section will carry water and a lower bed will contain oil or gas.

Bulletin 55 of the Oklahoma Geological Survey describes the various zones of the Simpson group. A summary of these descriptions in their descending order follows:

The Bromide formation, as measured at the outcrops, ranges in thickness from 145 to 440 feet. The formation, Mohawkian in age, consists mainly of limestones and shales with a sandstone bed at the base. This sandstone bed varies in thickness from eight to 283 feet. The heavy limestone near the top of the formation is usually dense and gray to yellowish brown. The shales are usually gray in color, and the percentage of dolomite in the formation ranges from 0 percent to 20 percent. Insoluble residues of the Bromide, from outcrop samples, show small amounts of milky chert. Platy shales are mostly gray but some are green and red. The quartz residues show sausage shaped coarse grains to medium sized rounded grains.

The Tulip Creek formation ranges from 0 to more than 450 feet thick at measured outcrops. It is composed mainly of a limestone member near the top and alternating thin beds of sandstones, green shales and a basal sandstone from 0 to 300 feet in thickness. The percentage of dolomite in this formation ranges from 0 percent to 23 percent. Insoluble residues show very little chert. The shales are usually green, red and black. The quartz is fine to coarse, showing secondary growth.

This zone is missing in the central, eastern and northeastern parts of the mountains. Fossil evidence indicates the Tulip Creek is a transitional formation. This evidence along with the evidence of a depositional hiatus between the Tulip Creek and the McLish formations would place the Tulip Creek formation in the upper Chazyan stage of deposition.

The McLish formation, placed in the middle Chazyan stage, is from 120 to 530 feet thick at the outcrop and consists of a basal sandstone bed with limestones, shales and sandstones in varying proportions forming the remainder of the formation above. The shales are usually green. Insoluble residues show cherts are more common and are greasy, green gray in color. The shales are predominantly green with some gray and red. The quartz is fine to coarse. The large

grains are pitted and etched irregular aggregates. The percentage of dolomite ranges from 0 percent to 24 percent.

The Oil Creek formation, as measured, varies from 50 to more than 1,000 feet thick. This formation, placed in the lower Chazyan, consists chiefly of limestones and shales in the western part of the mountains and of sandstones and limestones in the northern and eastern parts. The basal sandstone bed of the Oil Creek ranges from 0 to over 200 feet thick. The percentage of dolomite ranges from 0 percent to 8 percent. Insoluble residues show chert to be quite common. The shales are red, gray, green and black. The quartz is fine to coarse and the large grains are frosted and pitted.

The Joins formation is the lowermost member of the Simpson group. At the outcrops this formation varies in thickness from 0 to nearly 300 feet. It consists mainly of shales, shaly limestones and some conglomerates. Since it lies on the deeply eroded surface of the Arbuckle limestone, it would be normal for its distribution to be local and varied. The percentage of dolomite in the Joins varies from 0 percent to 16 percent. Insoluble residues show some cherts and some oolites. The quartz grains are fine to medium and are etched and pitted. The Joins formation is in the lower Chazyan.

There is no marked unconformity between the Simpson group and the Trenton, which has been called a part of the Viola limestone. However, there is a definite unconformity between the Fernvale of the Viola and the Trenton. Therefore, the close of the Mohawk stage is represented by this unconformity and the Fernvale Viola is in the Richmond age.

The variable character of the Simpson around the Arbuckle mountains can be explained by a variable land mass to the east and to the northeast which shifted toward the southwest and back several times during the period in which sediments were deposited. Until the beginning of the time of the deposition of the Sylvan shale and the Viola limestone (Richmond), the area between the Arbuckle

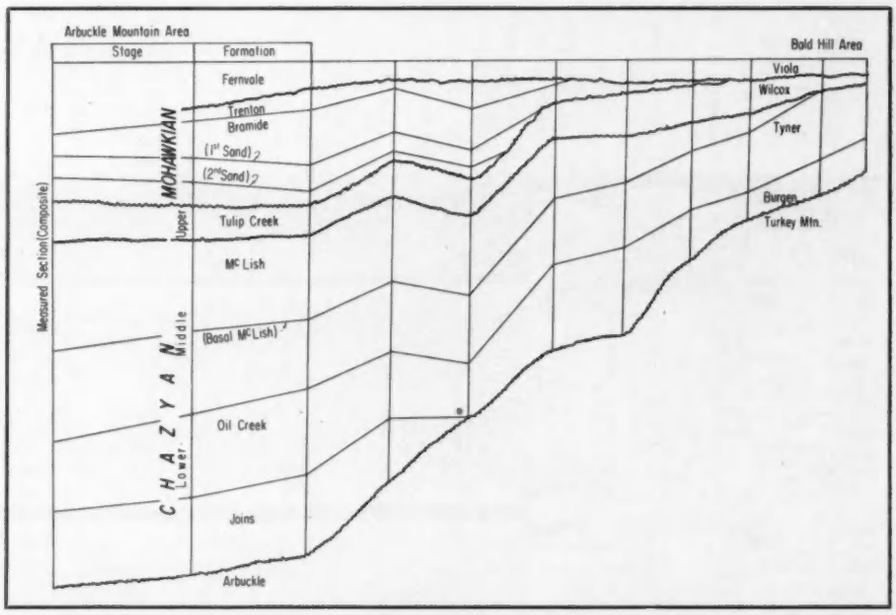


FIGURE 3—A stratigraphic correlation of Cross-Section A-A′ with the top of the Viola used as the datum plane, no horizontal scale. It should be observed that the Joins formation disappears against the northward rising surface of the Arbuckle limestone about midway of the section mapped. The Oil Creek formation continues to overlap both the Joins and the eroded surface of the Arbuckle. It becomes the section in which the Burgen sandstone is found in northeastern Oklahoma. Note that the first and second sands of the Bromide disappear in approximately the same area of the cross-section where the Joins formation becomes absent. From this evidence it could be interpreted that this line of weakness was rejuvenated after Tulip Creek deposition.

mountains and the Ozark uplifted area experienced many oscillations. The hiatuses in the Simpson outcrops indicate that the northern parts of the mountains were elevated and part of the Simpson deposits were eroded away during these stages of elevation.

The McLish formation, or more specifically, the basal McLish, was laid down conformably upon the Oil Creek formation and is called the Tyner of northeast Oklahoma. After deposition of the McLish sediments, uplifting occurred in the northern area and most parts of this uplifted area experienced much erosion. The Tulip Creek formation then was deposited on this more or less peneplaned surface. Some areas, as the northern parts of the Arbuckle mountains, remained above sea level and, instead of Tulip Creek deposits, a hiatus is found.

After the deposition of the Tulip Creek or Wilcox sands of northeastern Oklahoma, the area again was subjected to movement and erosion. This post Tulip Creek erosion was not as extensive nor did it last as long as the previous period. The Bromide formation and the Trenton dolomites were deposited in this area before another period of erosion occurred.

The Tulip Creek sandstone, as it was deposited on the unconformable surface of the McLish formation, could be in contact many times with outcropping sandstones of the McLish. When this condition occurs and the upper sandstone bed is a trap for petroleum, the resulting accumulation is greater than normal.

There are several oil pools in northeastern Oklahoma, producing from Pennsylvanian sands, which illustrate this condition. The Cleveland Pool of Pawnee County, the Burbank Pool of Osage County and others have the sandstones of one zone in contact with the sandstone of a previous deposition. This results in a greater thickness of sandstone and also to much higher recoveries than is normally afforded these Pennsylvanian sandstones. The migration of the hydrocarbons from the lower bed into the upper bed could be through cracks and fissures that resulted from uplifting movements after the sandstones were deposited. **—The End**

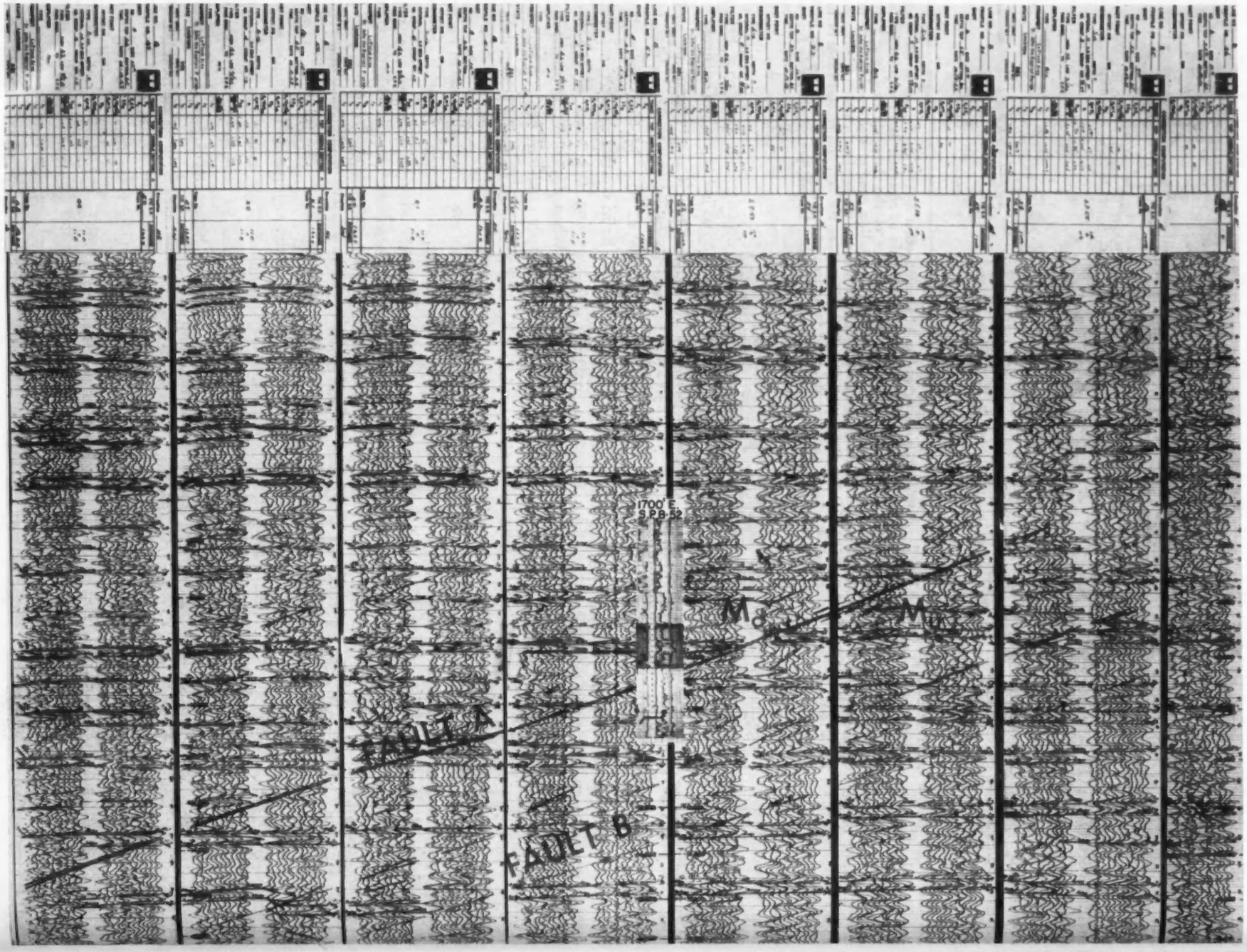
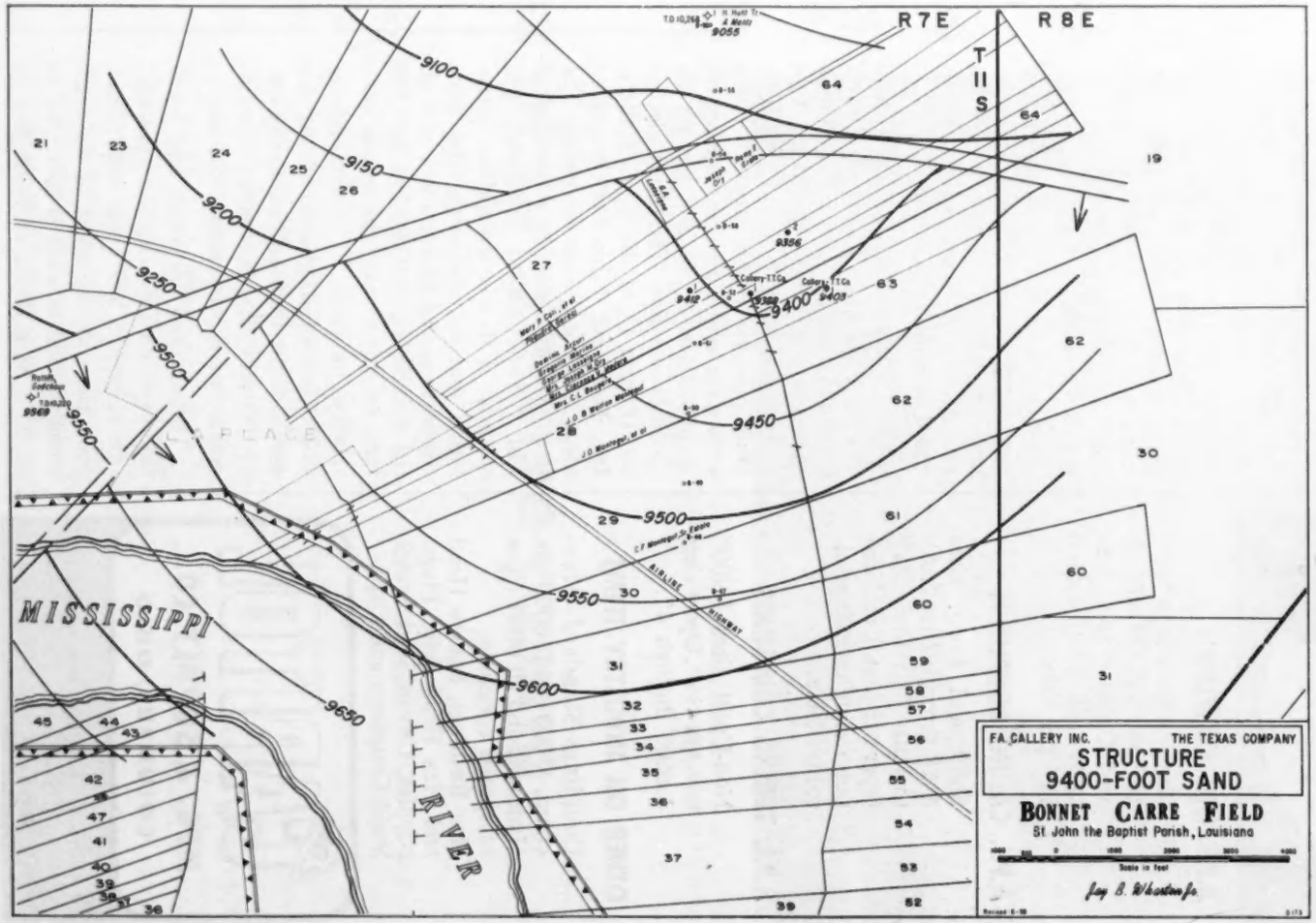


FIGURE 1—The seismic record above was obtained from a north-south line across the new Bonnet Carre field of South Louisiana.

FIGURE 1—The seismic record above was obtained from a north-south line across the new Bonnet Carre field of South Louisiana. Note excellent correlation between record section and the insert electric log. Insert log has been reduced to seismic depth scale.

Buried fault indicated by seismic record data

FIGURE 2—Below is structure map of the 9,400-foot sand of Bonnet Carre field. The line of shot points used in obtaining the seismic record section shown in Figure 1 is shown in relation to the rest of the field.



Seismic information accurately predicted the existence of a buried fault in the Bonnet Carre field of Louisiana. Electric log correlation substantiated the seismic interpretation.

By Stanley M. Leventhal
Index Geophysical Surveys, Houston

A TEXTBOOK example of seismic delineation of a buried fault has been found in the Bonnet Carre field of South Louisiana. The fault was clearly indicated on the seismic record section obtained prior to development. Comparison with electric log data secured while drilling substantiates the accuracy of the seismic work.

For many subsurface geologists it is often difficult to visualize how the seismograph delineates buried faults. Figure 1 is an excellent example of this occurrence. Bonnet Carre field is located in T11S, R7E,, St. John the

Continued on next page

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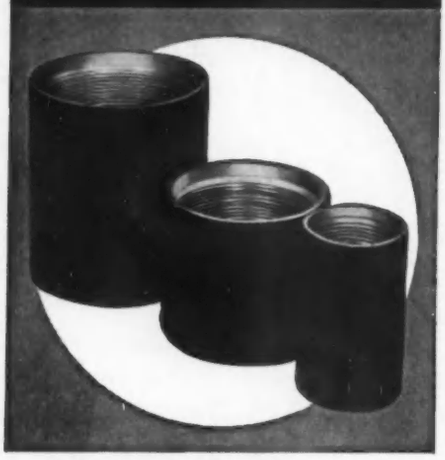

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Baptist Parish, Louisiana. The Department of Conservation Hearing; Docket 58-114; Bonnet Carre Field, Exhibit 1, revised structure map of the 9,400-foot sand, shows the location of Line B, the seismic record section in relation to the field (Figure 2).

• The discovery well, F. A. Callery, Inc. Montegut 1 (1700 feet East of Shot Point B-52) was completed as a dual producer in January, 1958. Production was from a gas-oil sand at 9,015 feet to 9,030 feet and an oil sand from 9,400 feet to 9,470 feet. Subsequently, three other producers have been completed in the field.

The seismic record section is a composite of eight seismic profiles in line with north to the top of the section. Instrumentation consisted of a portable 24-trace system with four marsh geophones per trace. A 20 percent mixed circuitry was used with individual shot holes normally spaced 1,200 feet apart and in line with the geophone spread.

Since the subsurface geologist is familiar with electric logs, it is believed that this seismic record section presentation of data will strike a chord of familiarity in use.

On the record section Fault A, a down-to-the-coast fault, is clearly identified with excellent fault break shown at 9,700 feet (the Marginulin ascensionensis lime) at S.P. 53. This fault provides north closure along with some north dip for trapping an accumulation of oil and gas on its downthrown side. The insert electric log (Figure 1) of the F. A. Callery, Inc. Montegut 1 has been migrated along strike on the record section. The strong seismic reflecting event marked Md (down-thrown) and Mu (upthrown) is shown in excellent correlation and approximately the same thickness as the Marginulina pick on the electric log at 9,690 feet to 9,950 feet. At this marker the seismic correlation indicates 50 milliseconds or ± 250 feet of displacement. At the depth of the fault call in the well at 11,100 feet displacement has increased to approximately 800 feet.

The unequal horizontal and vertical scales on the seismic record section suggest a low angle fault; however, the true dip angle of the fault when plotted to scale is indicated to be 55°. At a depth of 7,800 feet at S.P. 55, Fault A is shown to be dying out and buried as the shallow reflecting events above 7,000 feet continue in character and correlation without disturbance. Minor faulting (shown below Fault A and Fault B) is a small fault called in the H. Hunt Trust-A. Montz dry hole 200 feet north of S.P. B-56. Good depth penetration is indicated on seismic records to a depth of 15,000 feet.

The seismic record section is considered a good example of a buried fault because:

• There is clear identification of the same reflecting event on the down side and the up side of the fault cut across a single profile.

• The shallow reflecting events are not interrupted while those at 7,800 feet and below are cut by faulting.

• Well defined correlation is apparent between certain geological markers evident in the subsurface (electric log) and seismic (reflections.

Graphically portraying such seismic data for fault evaluation should be of use to the subsurface geologist.

ACKNOWLEDGMENT

The author wishes to thank A. L. Morgan, chief geologist, and Dr. J. R. Schander, chief geophysicist, of F. A. Callery, Inc.; Jay B. Wharton, Jr., consulting geologist, Lafayette, La.; and The Texas Company for their assistance and permission to publish this article.

About the Author

Stanley M. Leventhal received a B.S. degree in geology from Texas A. & M. College in 1946. He was employed as a computer and party chief by Geophysical Service Inc. from 1946 to 1951. After serving one and one half years in military service, he rejoined G.S.I. and served as assistant to the vice president of the marketing department from 1953 to 1954. He organized Index Geophysical Surveys Corp. in 1954, and is presently serving as president and supervisor of the corporation. He is a member of AAPG, SEG and the Houston Geological and Geophysical societies.

New record is set as Phillips Petroleum runs . . .

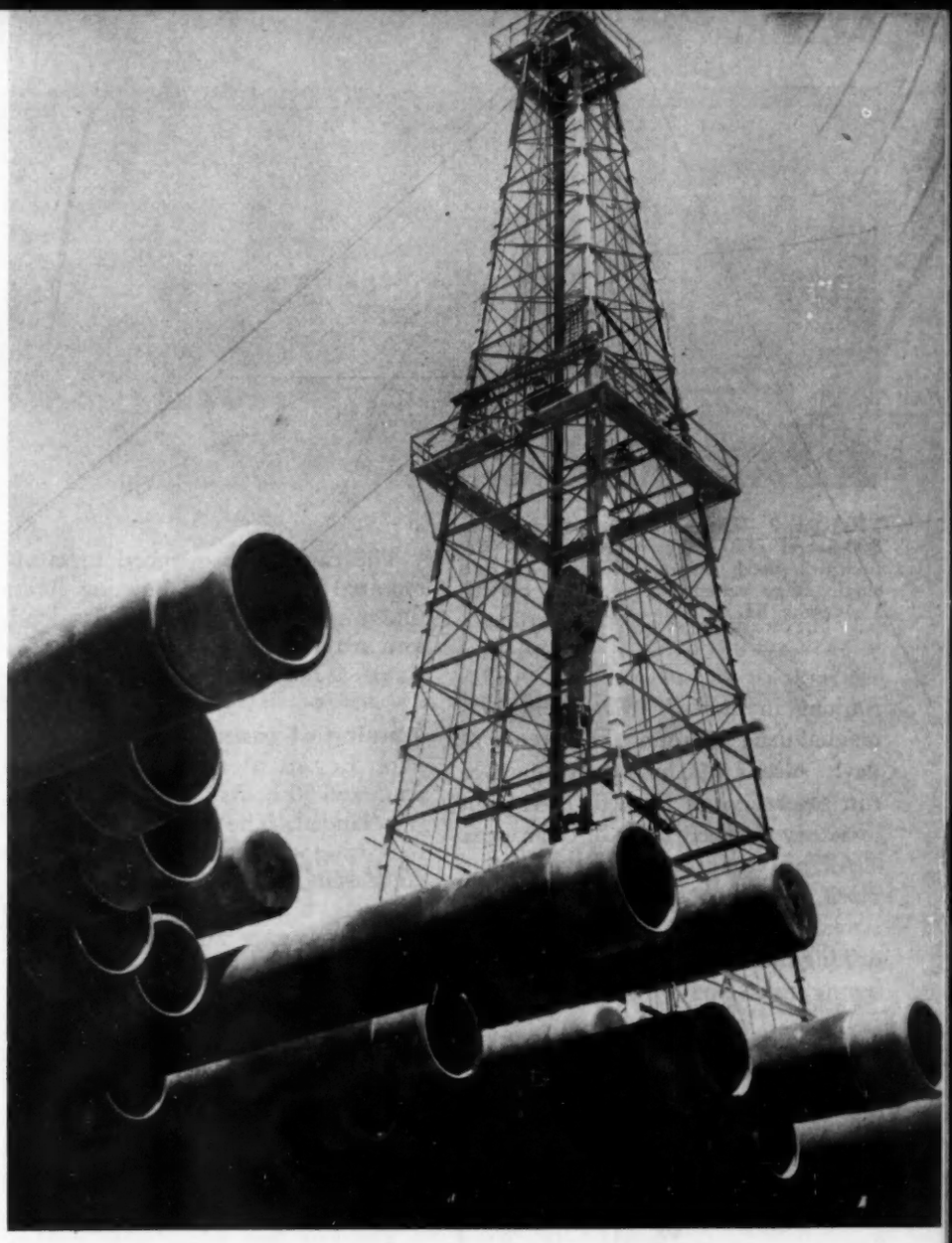


FIGURE 1—This 7-inch casing is part of the longest protective string ever run in the drilling industry. This record was set by Phillips Petroleum Company in its University EE 1 well 10 miles east of Fort Stockton, Texas.

22,919 feet of protective casing

World's deepest well near Fort Stockton is protected with 7- and 7⅝-inch casing set by the longest single stage cementing operation ever performed.

By Jack F. Earl
WORLD OIL Staff

PHILLIPS PETROLEUM COMPANY recently ran the longest string of casing and single stage cementing operation ever recorded in the oil industry on its University EE 1 well 10 miles east of Fort Stockton, Texas. When the projected depth of 23,000 feet was revised to 25,000 feet, the operator decided to run casing to protect the 11,900 feet of open hole.

Extensive planning was undertaken by Phillips Petroleum personnel and allied companies to minimize any problems. Hoisting requirements, physical examination of the 7-inch and 7⅝-inch casing, the cementing procedure and operation, safety precautions, necessary standby equipment were discussed. All personnel were instructed thoroughly in the overall operation.

Pre-planning and design. The casing was thoroughly inspected prior to

FIGURE 2—These four pumpers and two 500-barrel mud tanks were part of the facilities used during Phillips' record single stage cementing operation on the University EE 1.

running in the hole. Each joint was magnafluxed to insure the absence of flaws. Also, a 5¾-inch drift plug was run several times through each joint to satisfy required internal clearances.

All hoisting equipment, traveling block, elevators, spiders and drilling lines were rated at 500 tons. The drilling line system was completely re-strung using twelve 1⅜-inch lines.

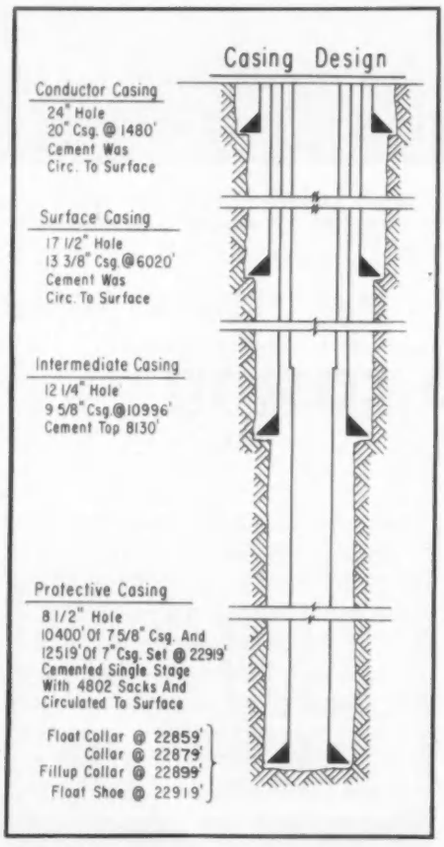


FIGURE 3—This schematic diagram describes in detail Phillips' casing program on its record-breaking well.

The casing was designed to satisfy required tensile and bursting forces that would be incurred at this depth and anticipated conditions (see Table 1).

Running of casing. The casing operation began at approximately 8:45 a.m., and 30 hours later the final joint was landed. The actual running of the casing was undertaken by a casing crew using air tongs. For added precautions, a standby set of air tongs and compressors was on the location. Two complete crews alternated every 12 hours. Four sets of stabbing boards were erected so various lengths of casing could be stabbed without interrupting the running of the pipe.

Phillips did not feel that the clearance between the pipe and the well bore would justify running centralizers and/or scratchers.

The first five joints were welded. From three quarters to one hour was allowed for cooling prior to running in the hole to minimize crystallization of the casing.

Casing was run with a float shoe on the bottom, a fill-up collar at the first joint and two float collars on the next two joints. The excellent properties of the low solids emulsion drilling mud was an important factor in the success of the operation. Circulation was broken twice; once, after reaching the bottom of the intermediate casing and another, approximately 5,000 feet off bottom. Circulation was obtained with approximately 300 psi. At 18,000 feet, the casing was floated to bottom.

The calculated weight was 650,000 pounds; however, the greatest weight indicated at the surface was 560,000 pounds.

Cementing operations. The cementing operation was unique in that it was the longest single stage cementing operation ever performed. The previous longest single stage cementing job was believed to be a 15,000-foot operation located in the Puckett field, 20 miles south of the present location.

When discussing the cementing requirements of this operation, Phillips considered the following conditions:

- The slurry had to remain fluid

Continued on Page 84

Phillips' personnel designed this 22,919 feet of casing to satisfy required tensile and bursting requirements . . .

TABLE 1—Casing Design

No. of Joints	Size	Weight	Grade	Type	Condition	Length (Feet)
26	7 inch	38 pound	P-110	8 Rd	1	816.97 LT&C
9	7 inch	38 pound	S-95	8 Rd	1	438.26 ST&C
1	7 inch	38 pound	P-110	8 Rd	1	33.96
69	7 inch	35 pound	P-110	8 Rd	1	2,601.74 LT&C
62	7 inch	32 pound	P-110	Hydril	1	2,579.92
85	7 inch	29 pound	P-110	8 Rd	1	3,472.03 LT&C
62	7 inch	26 pound	P-110	Buttress	1	2,577.76
178	7⅝ inch	29.7 pound	P-110	Extreme	1	7,146.06
37	7⅝ inch	33.7 pound	P-110	Extreme	1	1,515.55
43	7⅝ inch	39.0 pound	P-110	Extreme	1	1,734.70
Total Pipe						22,893.00
Shoe & Flot Collars.						6.65
Total						22,899.65
Landing JT.						19.35
Total Depth						22,919.00

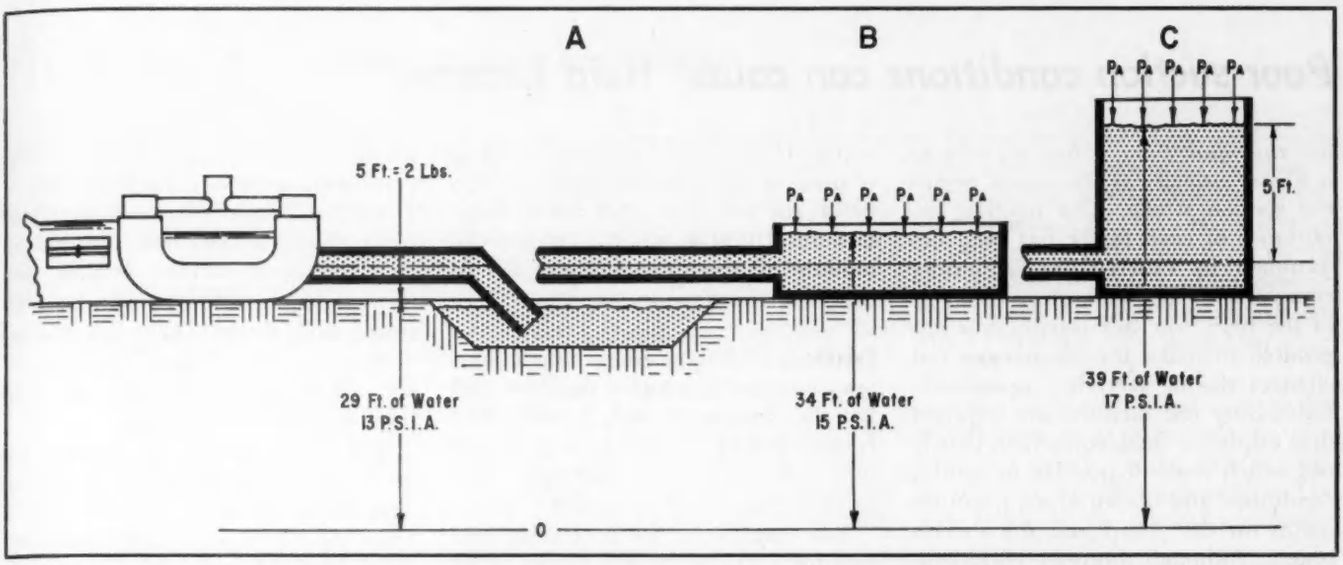


FIGURE 9—A schematic of various types of mud suction systems in use in the field. For the same size pipe and the same weight mud, it is apparent that the tank with the larger hydrostatic head is the most desirable while the flooded suction has an advantage over the earthen pit that is below the pump suction flange.

PART 2: SUCTION PIPE AND ACCELERATION

Know your mud pump--it can save you money

How critical are friction losses in your system? Are they the most important sources of pressure loss? What about inertia?

By Samuel L. Collier
Mission Manufacturing Company,
Houston

THE MUD PUMP can be run smoother and faster with less parts wear if suction requirements of the pump are well understood. Although frictional losses in the suction piping are important, the inertia of the mud in the suction pipe is equally as important. Therefore it is necessary to review the suction requirements and consider the demands of the system with friction and inertia both involved.

This is a new and more accurate method of comparing and correcting difficulties that may occur due to the changes in operation, such as pumping at higher speed, hot mud, pumping from a low pit level, or changes in construction, such as longer suction lines and the inclusion of ells.

The ordinary suction hookup is so familiar to rig personnel that its significance may be overlooked. A mud pump will pull a high vacuum; therefore, absolute pressure (gage pressure + 14.7) rather than gage pressure should be used when considering the suction condition.

The pressure differential between this atmospheric pressure and the low pressure in the cylinder is the force that pushes the fluid into the suction pipe. Thus, a fully primed pump that has its suction exactly flooded and which has atmospheric pressure on the liquid in the mud tank has a 15 psia suction pressure (or 34 feet of water).

Figure 9 illustrates this and two other suction arrangements. When pumping from a tank (C), the absolute suction pressure, when the mud level is 5 feet above the pump suction, is 17 psia. When the mud level is 5 feet below the pump suction (A), the absolute pressure is 13 psia. Since the maximum pressure available to work with is atmospheric plus a small elevation, the mud source must be fairly close to the pump.

Use of the suction pressure. The available pressure is partly consumed by the frictional losses. Additional pressure is required to keep the mud from boiling and to push and hold the suction valve open. *These pressure losses are usually less in magnitude than the pressure required to acceler-*

Poor suction conditions can cause "fluid hammer"

ate the mud from a low velocity to a higher velocity as the piston begins the suction stroke. The relative importance of each factor has been determined by controlled laboratory comparisons. The laboratory could be in the field, too, but usually it is impossible to make the necessary test changes during drilling operations. Laboratory test facilities are required that duplicate field equipment closely but which make it possible to control conditions and obtain exact measurements on the pump and the suction system. Although thorough consideration of simple measurements is very useful because of the pulsating nature of the pumping system, it is simpler to make the studies with electronic instruments and high frequency recording equipment. This type of study makes it possible to consider each factor and give it proper consideration in the over-all problem of obtaining and keeping satisfactory suction conditions.

Prevention of boiling. The importance of mud temperature was emphasized in the introductory article (WORLD OIL, July, 1958, Page 100). Additional comments at this point should provide a better understanding of the problem.

Boiling or vaporization occurs when the pressure within the liquid reaches the pressure over the liquid and particles boil or leap out of the fluid. Thus, the vapor pressure of water is equal to the atmospheric pressure at sea level when it reaches a temperature of 212° F. i.e., it has a vapor pressure of 14.7 psi. If the pressure above the liquid is reduced, the liquid will reach its vapor pressure and boil at a lower temperature. This is the condition that arises during the suction stroke when the pressure in the pump drops very low, and mud can boil at a lower temperature. A part of the pressure available must be used to prevent boiling.

Figure 6 of Part 1 showed the vapor pressure of water that can be used to estimate the required pressure. Water and oil base muds usually will have vapor pressures that differ from water and can be expected to behave about as salt solutions. Generally, such solutions have a vapor pressure lower than water. If the vapor pressure of water is used in calculations, estimates will be on the safe side. This curve shows how mud that is too hot reduces the amount of absolute pressure left to overcome friction and inertia.

Friction. Frictional loss calculations are more familiar to the operator and will be considered only briefly. The friction loss in a straight short suction pipe calculated for the peak flow through the pump is relatively small.

For example, at the maximum flow rate for a 7½-by-14-inch pump at 70 spm equipped with an 8-inch suction pipe, 25 feet long, the frictional loss is 0.1 psi. This is only a very small portion of the 15 psia suction pressure available with a flooded suction as shown in Figure 9. A 12-inch pipe would reduce this loss to 0.02 psi, but in either case the loss is negligible. Compare this relatively small frictional loss to the 7 or 8 psi of pressure that normally is required to overcome inertia.

However, poor design will take its toll in frictional pressure loss. For example, a single 90° miter used instead of an ell in the above 8-inch suction system is, by itself, the equivalent in frictional losses of 50 feet of suction pipe, or it causes twice as much loss as the entire suction pipe itself. Even a small frictional loss might become critical if multiplied by a number of such ells or miters. Such construction definitely should be avoided.

Velocity head. One additional element should be added to the suction pressure consideration before inertia is considered. This is the small amount of pressure necessary to create the flow velocity. This pressure is the velocity squared divided by twice the gravitational constant (g) converted to psi.

In the previous example, at the peak flow through the pump of about 800 gpm, the velocity in the 8-inch suction pipe is 5 feet per second and the velocity head is 0.4 feet of water, or 0.16 psi.

Acceleration to overcome inertia. Unsatisfactory operation caused by poor suction conditions appears as fluid hammer in the fluid end of the pump. The development of knocking conditions occurs at the beginning of a suction stroke. At this point, the power pump experiences the greatest piston acceleration. It then goes through zero acceleration at mid-stroke and decelerates for the remainder of the stroke. The fluid resistance to these changes or fluid inertia must be overcome.

The pump operator's interest is not in the details of the knocking mechanism but in the means of preventing it. Since the piston acceleration is a maximum at the beginning of the stroke, it is necessary to determine if and when this will become a critical factor.

Imagine a single piston operating at a low speed connected by a short length of pipe to a mud tank. The mud has no difficulty following the slowly moving piston. At high speed the mud will not be able to move as rapidly as the piston and a small void will form. At the instant at which the operating speed becomes so great that a void first forms—a significant change occurs.

Below this critical speed, the fluid and the piston move in unison. Neglecting compressibility, the piston and the fluid exhibit the same characteristics of velocity and acceleration from beginning to end of the stroke. The two phases are separated by a void at the critical speed and the behavior of the piston and mud differs.

The forces at work at the start of the stroke can be studied easier by comparison with a similar but slower process. When a valve in a line from a mud reservoir to a large vacuum tank is opened, the mud which has been at a standstill slowly begins to move, and after a period of acceleration develops a good flow into the tank. Atmospheric pressure on the surface of the mud in the reservoir pushes the mud into the vacuum tank. The force available to push the mud is atmospheric pressure (14.7 psia) multiplied by the pipe area (in square inches). In this example, pressure in the vacuum tank is zero psia, but if the vacuum tank pressure were not this low, it would offset part of the accelerating force. The remaining force may or may not be able to over-

Fluid inertia . . a major consideration!

come the inertia of the mud in the suction pipe.

The process in the mud pump is similar to this. The piston produces the vacuum, and the mud is pushed in from the reservoir following the same physical law. But the action is much more rapid.

If the pressure available had been sufficiently high or if the inertia (pipe length and gravity) had been sufficiently low, acceleration of the mud and the piston would be equal. If this were accomplished at the start of the stroke when acceleration is maximum, no void would occur. Contact between the mud and the piston would be continuous throughout the stroke. Knocking would not result and the pump operation would be normal.

It is important for the operator to be able to determine the pressure required for his particular installation and operation. The formula (E1) shows that the suction pressure will produce a certain acceleration in the suction pipe, depending on pipe length and mud weight. The pipe cross-sectional area does not influence the acceleration produced by any given pressure. The force available divided by the area is the pressure thus eliminating the effect of area. However, the ratio of suction pipe area to piston area affects the acceleration required in the suction pipe to match the piston's acceleration.

A calculation of the typical system will show that the pressure required to overcome inertia is several pounds. This is a much larger portion of the total suction head required than the fraction of a pound frictional loss that develops through the average suction pipe. This simple calculation will not give the complete suction head required because of complications introduced by the double acting duplex mud pump.

Friction and acceleration must be overcome at the same time in the pump. Although one piston is at the end of the stroke, the other normally will be at mid-stroke and will have attained its maximum velocity. Although little acceleration is required for the piston at mid-stroke, its high velocity will account for a certain frictional loss.

A certain amount of pressure will be required to overcome the inertia of the suction manifold of the pump and to open the suction valve. These are the pump losses and, although they can be estimated it is best to determined their value experimentally. However, as test data on each individual pump usually are not available, some typical results are presented as follows.

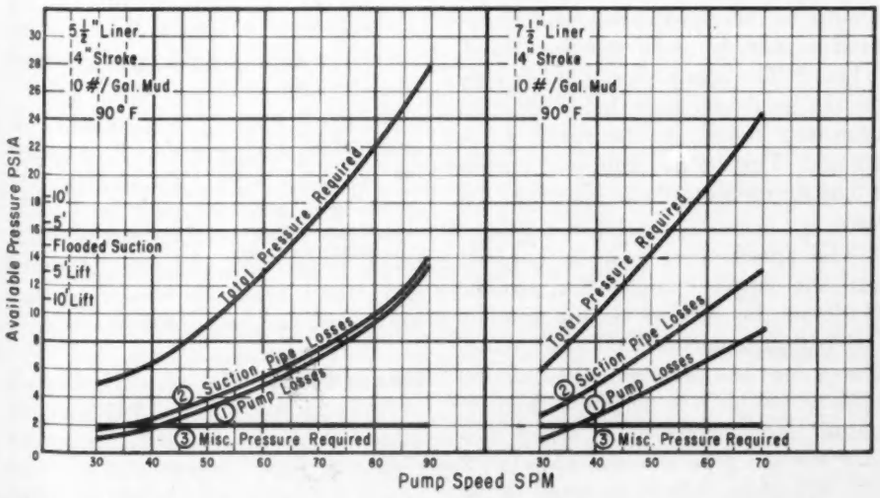


FIGURE 10—For given conditions, this chart shows different pressure losses for two sizes of pistons. Note how all the losses increase with an increase in speed, and the percentage of available pressure that is absorbed in overcoming these losses.

Pump losses are somewhat higher than might be suspected because of the complex inertia problem in the suction manifold. A certain amount of pressure is required to open the suction valves rapidly. This pressure varies with the valve size and design, but an average valve would be about 2 psi.

The typical suction manifold design will require as much as half the pressure to overcome inertia as is required in an entire straight suction pipe. This is a result of the several application practices:

- Of designing various legs of the suction manifold smaller than the suction line. This requires a greater acceleration in the mud in the branch than in the mud in the suction pipe for a given condition and therefore, requires a greater pressure.

- The design of a suction manifold where the mud is at a complete standstill in some legs between pump strokes. The mud in the suction pipe never stops completely and thus never requires acceleration from a standstill. In a branch of the suction manifold, the mud is at a standstill unless the liquid is flowing into the piston cylinder. If this leg is long, pressure required to overcome the inertia is increased. The force required depends on individual design but test results indicate that the extent of this dependence is not nearly as significant from pump to pump as the differences that occur in the remainder of the suction piping and the tankage systems.

Estimate of required pressure. Suction pressure required for a typical double acting duplex pump is given in Figure 10. Comparisons can be made between this data and field installations, and should be a useful guide when making changes in the system. The total pressure required is the sum of the pump losses and the suction pipe losses.

1. Pressure required to overcome pump losses.

This data has been obtained by subtracting curves (2) and (3) in Figure 10 from the total pressure required as determined by the test.

A figure of 7.3 psi was thus deter-

mined to be the pump loss at 70 spm. The pump losses are less than half of the total and probably will not vary more than a few pounds with different designs. Therefore, select a figure for the pump losses directly from this test curve for the speed desired.

2. Pressure required to overcome suction pipe losses.

The effect of variations of size, length and mud weight in the suction pipe can be estimated from the following expressions:

Determine piston acceleration:

Equation (E1)

$$Ap = 0.000456\ N^2S$$

For stroke (S) = 14 in.
$Ap = 0.00639N^2$

Ap = Piston Acceleration ft./sec²
N = Pump speed strokes per. min.
S = Stroke, inches

For stroke (S) of 14 in. at pump speed (N) = 70 spm
Ap = 31.3 Ft./Sec.²

Determine the suction pipe pressure required:

Equation (E2)

$$P_s = 0.001978\ L\ G \left(\frac{D_p}{D_s}\right)^2 A_p$$

P_s = Suction pressure psi
L = Suction pipe length, ft.
G = Mud Weight lbs/gal
D_p = Piston dia., inches
D_s = Suction Pipe dia, in.
A_p = Piston accel. ft/sec²

at L = 25 ft. G = 10 lbs/gal A_p = 31,3 ft/sec²
$D_p = 5\frac{1}{2}$ in. $D_s = 8$ in.
$P_s = 7.36$ psi

With the same conditions and $D_p = 7\frac{1}{2}$ in. $P_s = 13.4$ psi

It can be noted from equation (E1) that the piston acceleration increases directly with the stroke length and with the square of the speed. Since the suction pressure (E2) required for the piping is directly proportional to acceleration, the pressure required also would be directly proportional to stroke and to the square of the speed.

Also, from (E2), the pressure required to overcome suction pipe inertia is directly proportional to the length of the pipe and to mud weight. Increasing the diameter of the suction pipe (D_s) relative to the piston size (D_p) decreases the effective acceleration in the suction pipe by the square.

In the above example, the suction pipe loss for 25 feet of pipe is 7.36 psi. and for a 50-foot pipe would be 14.7 psi. If the mud weight had been 12 lbs/gal the loss would be 8.8 psi. By increasing the pipe diameter to 10 inches, the pressure loss in the suction pipe would be only 4.7 psi, a 2 psi improvement.

Figure 10 curve (3) gives the total of the minor pressure requirements for friction and vapor pressure.

The total pressure required will be the total of (1) + (2) + (3), or in the example; (1) = 7.3 psi. (2) = 7.36 psi. and (3) = 2 psi = 16.7 psi. Thus, to insure normal operation with this arrangement, a tank would be necessary with a minimum mud level that would give two psi above atmospheric. This would require the 10-pound mud to be a minimum of 4 feet above the suction flange of the pump. The use of a 10-inch suction diameter, which would reduce the total pressure required about 2 psi, would permit normal operation if the mud level dropped down to about one foot above the suction flange.

The data given for the test pump can be obtained for an individual system whenever trouble is encountered and some improvement in operation is desired. The pump should be discharged through an adjustable choke so the speed can be altered. The speed should be increased slowly and measured accurately when the first knock is heard. The pump should knock only on the head end and should develop increased knocks as the speed is increased. This information will permit adequate revision of the system as desired.

The speeds that can be handled and the simple changes that can be made in the suction system actually fall within a narrow operating band. On some installations, the suction tank would have to be placed high to permit large increases in speed if a long suction pipe is used. This problem will be considered in detail in the next two articles.

TO BE CONTINUED

Phillips sets a record

Continued from Page 80

long enough to permit it to be pumped into place.

- There had to be low water loss characteristics to minimize channeling or danger of flash setting.

In view of the requirements, the decision was to use these two additives.

1. A cellulose derivative—(carboxymethyl hydroxethyl cellulose for controlling the water loss and retarding the thickening time).

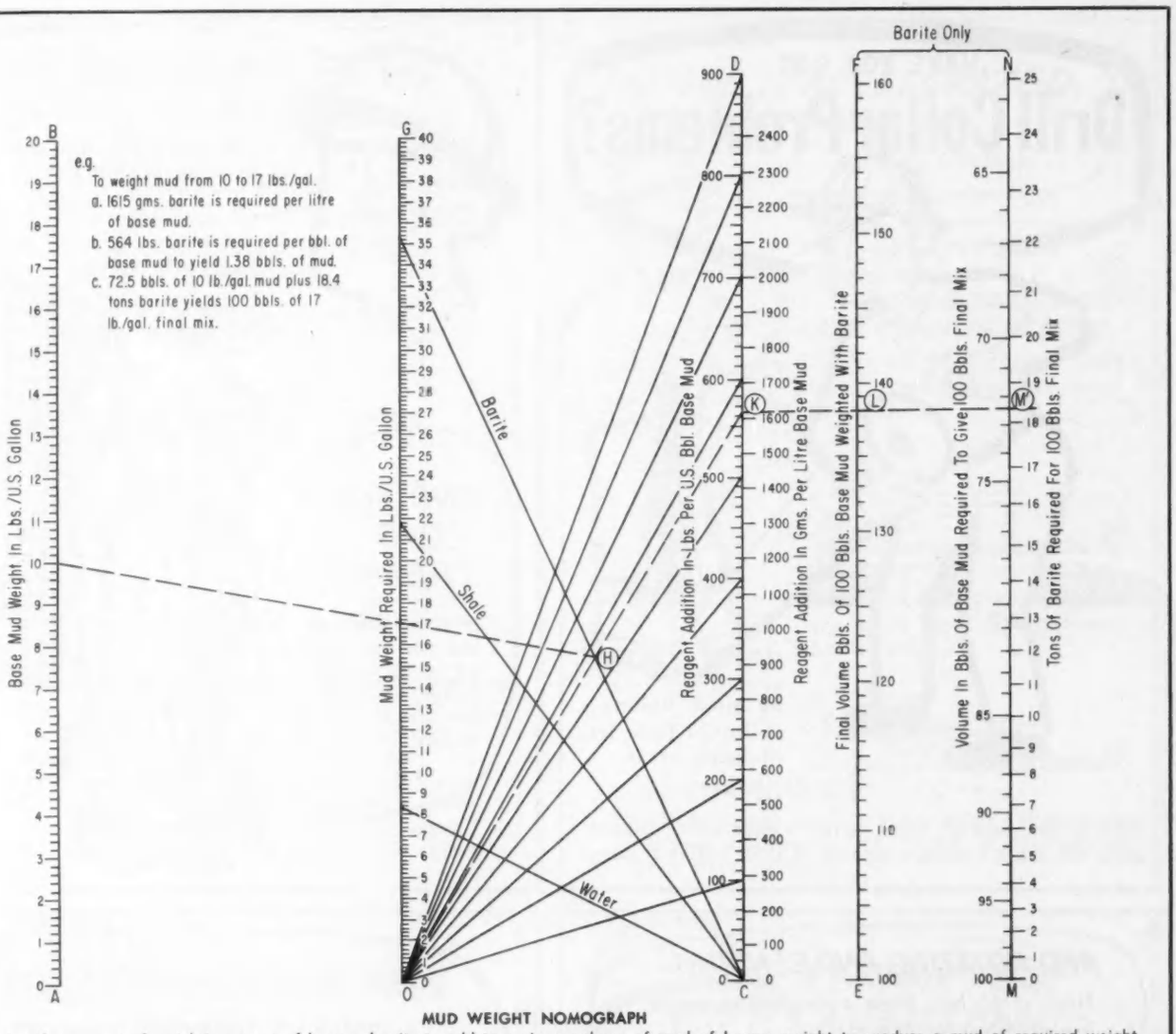
2. A special grade diatomatous earth (DE) admixed with cement, permitting formulation of low density slurries.

A total of 5,183 cubic feet of cement was displaced. This operation was divided into two phases. The first batch was 5,083 cubic feet of 40 percent diatomatous earth, 1.5 percent low water loss additive and common cement. The slurry weight was 10.8 pounds per gallon. The second batch included 100 cubic feet of cement and 0.5 percent water loss additive. This slurry was increased to 16 pounds per gallon.

The cementing operation—mixing, pumping and displacement—required three and one-half hours. The displacement rates varied from 6 barrels per minute to 14 barrels per minute with a pre-planned minimum rate of 6 barrels per minute. A maximum pumping pressure of 2,000 psi was recommended. The highest pressure recorded was 1,800 pounds per square inch; however, the stabilized injection pressure was 1,500 pounds per square inch. The total displacement time was 1 hour and 43 minutes. Phillips ran a temperature survey to ascertain the top of the cement which was indicated at 4,100 feet.

Figure 2 shows the equipment required for the operation. Five pumpers were on the location; with one standing by for emergency, four 1,200-cubic-foot filled storage bins; two 500-barrel mud tanks and one 250-barrel mud tank, four lo-boy cementing units, and one bulk cement truck.

Future Plans. The operator planned to drill ahead with a 5¾-inch bit, using 10,250 feet of 3½-inch 16.6 pound P. 105; 3,000 feet of 3½-inch Grade E 16.6 pound and 4-inch flush joint drill pipe. The drill collars will be fifteen 4¼-inch O. D.—**The End**


e.g.
To weight mud from 10 to 17 lbs./gal.
a. 1615 gms. barite is required per litre of base mud.
b. 564 lbs. barite is required per bbl. of base mud to yield 1.38 bbls. of mud.
c. 72.5 bbls. of 10 lb./gal. mud plus 18.4 tons barite yields 100 bbls. of 17 lb./gal. final mix.
Barite
Shale
Water
Barite Only
Base Mud Weight In Lbs./U.S. Gallon
Mud Weight Required In Lbs./U.S. Gallon
Reagent Addition In-Lbs. Per U.S. Bbl. Base Mud
Reagent Addition In Gms. Per Litre Base Mud
Final Volume Bbls. Of 100 Bbls. Base Mud Weighted With Barite
Volume In Bbls. Of Base Mud Required To Give 100 Bbls. Final Mix
Tons Of Barite Required For 100 Bbls. Final Mix

MUD WEIGHT NOMOGRAPH

To determine the amount of weighting agent of known density to add to a given volume of mud of known weight to produce a mud of required weight.

This nomograph answers the question....

How much weighting material to add?

By P. W. Cooke
The British Petroleum Co., London, England

Instructions

1. On scale AB locate base mud weight.
2. On scale OG locate required mud weight.
3. With a straight edge join the two points (e.g. 10 and 17 pounds/U.S. gallon) and produce to intersect the transverse barites line at H.
4. With straight edge join OH and produce to cut scale CD (at K) and read off on the scale CD the grams of barites required per litre of base mud *or* the pounds of barites required per U. S. barrel of base mud.
5. Draw horizontal line KLM to cut scales EF and MN and read off on scale EF, the resultant volume in barrels when 100 barrels of base mud is brought to the required weight. Scale MN gives the volume in barrels of base mud and the barites in tons required to yield 100 barrels of final mix.

N.B. (a) Scales EF and MN are applicable only to barites weighting.

(b) Similar calculations can be carried out employing the shale transverse line and indeed the transverse line corresponding to any weighting agent may be constructed by drawing a line from C to the point on scale OG corresponding to the density of the weighting materials.

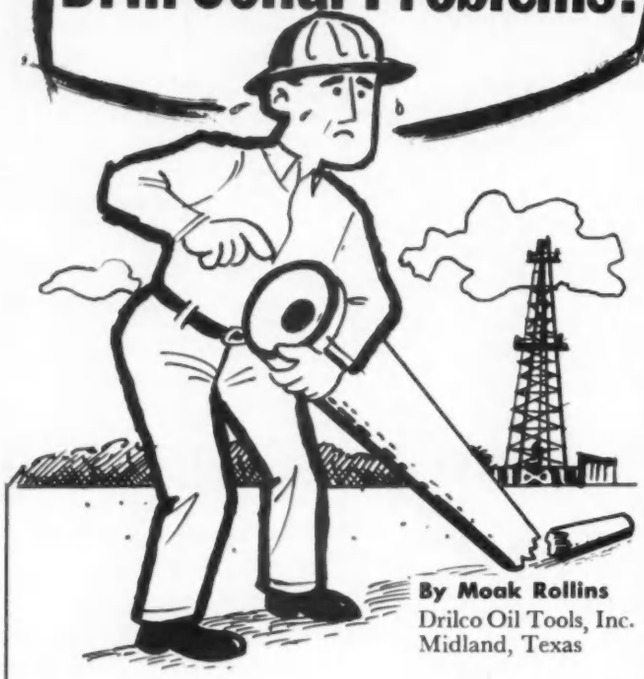
(c) Similarly, the transverse water line may be used in exactly the same fashion to determine the dilution required with water to produce a lower mud weight.

The example shown indicates:

1. 1615 grams of barites per litre of 10 pounds/U.S. gallon base mud will yield 1,380 millimeters of 17 pounds-U.S. gallon of mud.
2. 564 pounds of barites is required per barrel of 10 pounds/U.S. gallon base mud to yield 1.38 barrels of 17 pounds/U.S. gallon mud.
3. 72.5 barrels of 10 pounds/U.S. gallon mud plus 18.4 tons of barites yields 100 barrels of 17 pounds/U.S. gallon final mix.

HAVE YOU GOT

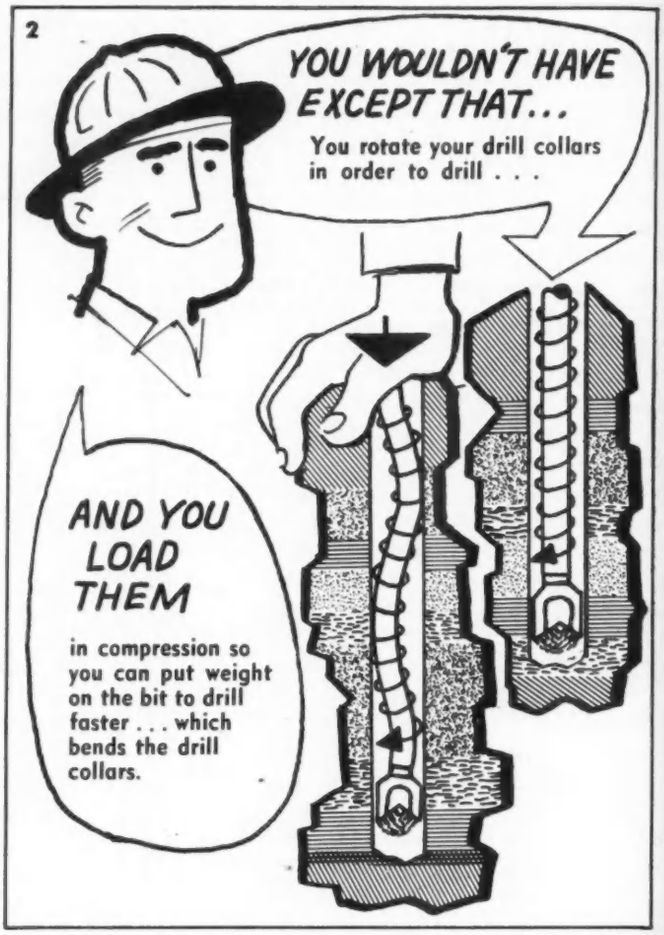
Drill Collar Problems?



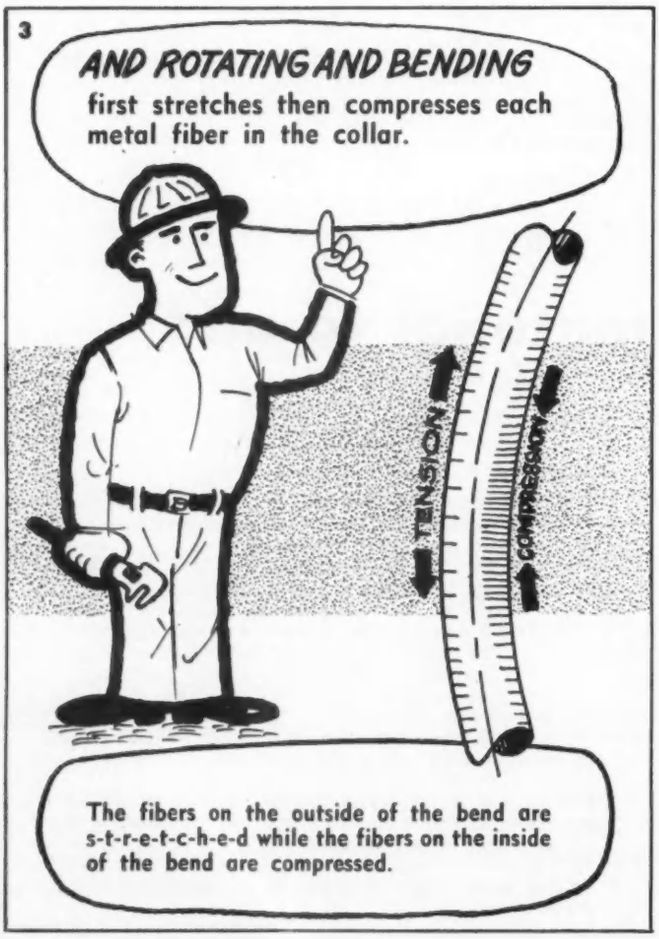
By Moak Rollins
Drilco Oil Tools, Inc.
Midland, Texas

This is the first of three articles explaining pictorially the most common causes of drill collar failure.

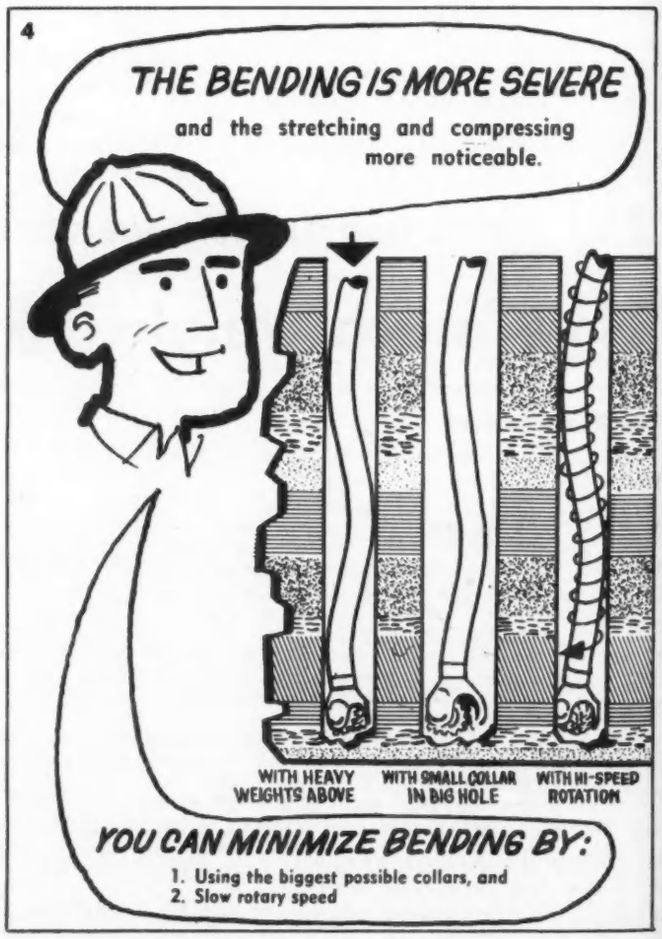
2


YOU WOULDN'T HAVE EXCEPT THAT...
You rotate your drill collars in order to drill . . .
AND YOU LOAD THEM
in compression so you can put weight on the bit to drill faster . . . which bends the drill collars.

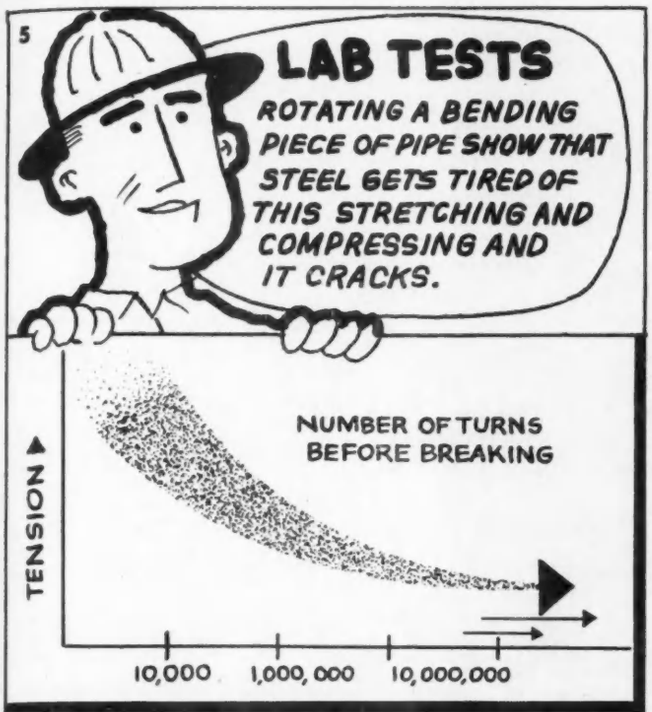
3


AND ROTATING AND BENDING
first stretches then compresses each metal fiber in the collar.
TENSION
COMPRESSION
The fibers on the outside of the bend are s-t-r-e-t-c-h-e-d while the fibers on the inside of the bend are compressed.

4


THE BENDING IS MORE SEVERE
and the stretching and compressing more noticeable.
WITH HEAVY WEIGHTS ABOVE
WITH SMALL COLLAR IN BIG HOLE
WITH HI-SPEED ROTATION
YOU CAN MINIMIZE BENDING BY:
1. Using the biggest possible collars, and
2. Slow rotary speed

5


LAB TESTS
ROTATING A BENDING PIECE OF PIPE SHOW THAT STEEL GETS TIRED OF THIS STRETCHING AND COMPRESSING AND IT CRACKS.
NUMBER OF TURNS BEFORE BREAKING
TENSION
10,000
1,000,000
10,000,000

The more severe the bending, the sooner cracks will occur. Making a number of tests like this at various loads produces a curve like the one above. This curve shows that when bending stress is great—life is short. If bending is small, the piece may rotate a very long time without damage. This rapid "aging" of steel under severe repeated bending is called fatigue.

6

AT A CHANGE IN SIZE--

—because the big piece won't bend. The little piece must bend—Here.

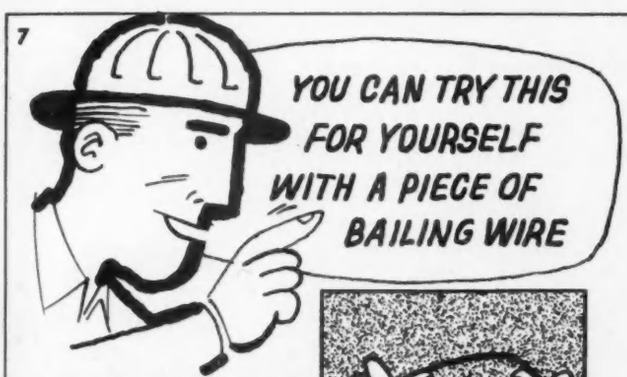
AT A NOTCH--

—because the flow of stress in the outer fiber is interrupted by the notch.

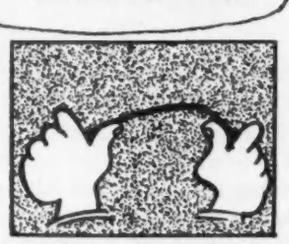
IN CORROSION PITS--

—because each pit is a sharp notch and because corrosion accelerates the growth of the fatigue crack once it starts.

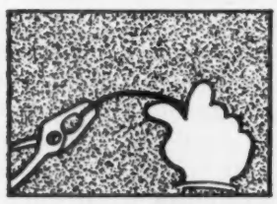
7



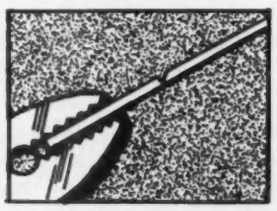
Grip it eight inches apart and try to break it by repeated bending—you'll work a long time.



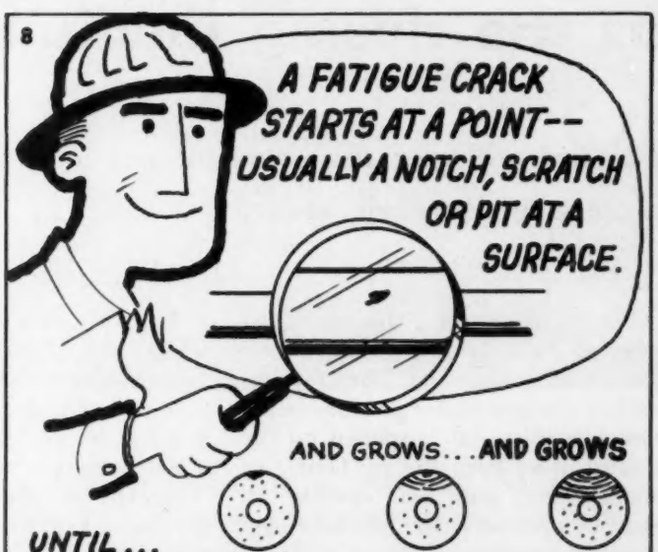
Grip it in some pliers, and bend it sharply where the pliers grip. It breaks after a short time, because bending is concentrated at the change in size where the wire is held by the pliers.



Notch the wire lightly with a file. Then, grip it at the notch with the pliers and bend. It will break after only a few bends. The sharper the notch and the sharper the bend, the faster the break will occur.



8

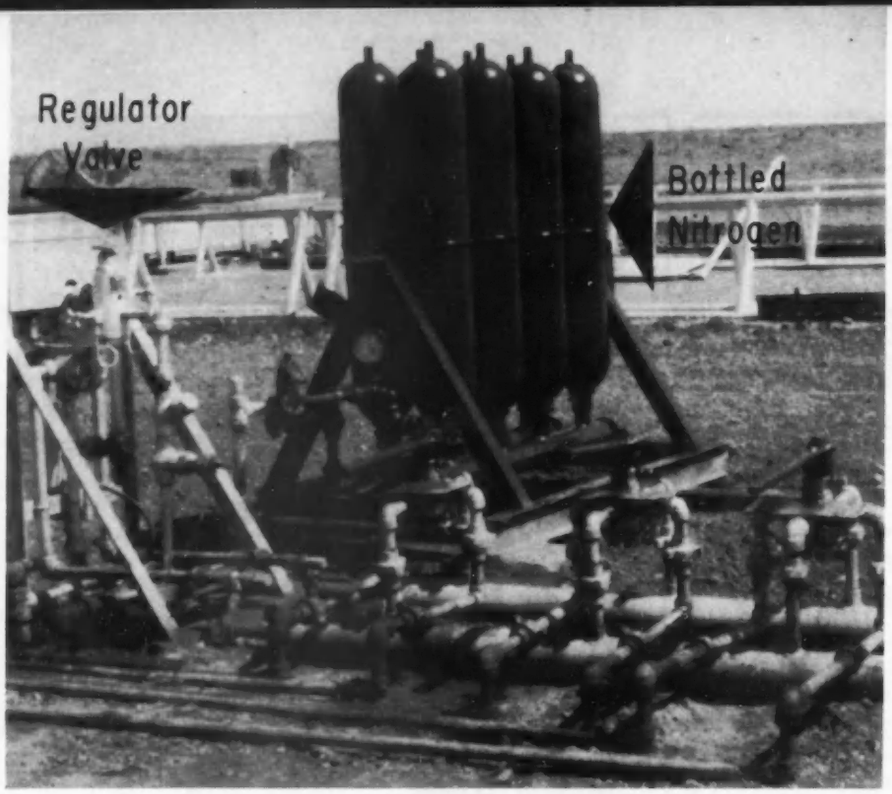


UNTIL . . .

there is not enough sound metal left to support the load. Then it breaks—

SUDDENLY!

Leaving a rough, jagged, crystalline appearance on the part which broke . . . and a smooth, polished appearance marked with a wave ripple pattern on the part that broke gradually. This wave pattern was formed as the crack progressed step by step.



Falcon Seaboard's auxiliary BOP closing unit is on ground and away from rig floor.

BOP hookup uses nitrogen as the closing medium

This unit will operate all blowout preventers in the event of complete loss of rig power.

FALCON SEABOARD DRILLING COMPANY of Tulsa is using a unique auxiliary BOP closing unit. The unit uses bottled nitrogen under pressure as the closing medium. It is spotted on the ground away from the rig floor (see photograph), and will operate all blowout preventers in the event of a complete loss of rig power.

The extra set of valves on the ground is hooked up with the valves from the closing unit on the rig floor. The air-operated pump on the floor has an automatic cutoff switch that shuts the air off the pump when 1,500 pounds on the oil pressure line is reached. The blowout preventer can be operated from the floor or from the valves in the yard by merely turning the valve to the closed or open position. The accumulator is tied into the pressure line.

The eight bottles on the accumulator contain nitrogen filled tubes with approximately 700 pounds of pressure each. Oil is pumped into the bottles by the closing unit pump until 1,500 pounds of pressure is obtained. The eight bottles hold a total of 80 gallons of fluid under 1,500 pounds of pressure, which is more than enough fluid to close the rams on a QRC and also to operate the accumulator.

A regulator valve on the stand between the valves and the rig is used only when operating the accumulator. When the regulator valve is turned all the way to the right, the full 1,500 pounds of pressure is applied to the accumulator preventer rubber.

The pressure against the rubber can be lowered to any desired amount by turning the regulator valve to the left. The recommended procedure to close the accumulator is to turn the regulator valve to the left until a little mud blows by the rubber and then turn it back to the right about one round.

In this way, the drill pipe can be rotated or worked upwards or downwards through the accumulator without damage to the rubber. The regulator valve will automatically keep the same pressure on the accumulator preventor rubber once the regulator valve is adjusted in the above manner. It will release some of the fluid as the tool joint is pulled into the rubber. However, the fluid then is replaced as the drill pipe (smaller in O.D.) passes through the rubber, since the pump on the closing unit still maintains the 1,500 pounds of pressure behind the regulator valve.

—The End

Moving day for the workover outfit. Moving a workover rig is a task requiring skill, coordination, teamwork. But the crew can take it in stride, for a portable outfit is mobile as a circus and is handled in the same efficient way. This picture shows a rig being moved off a typical flowing well in southern Louisiana.

The workover specialists had just finished servicing the well, which was over 10,000 ft deep. The job of pulling and rerunning tubing was done with the rotary line, a Bethlehem Purple Strand rope with IWRC. Purple Strand was also the choice of the trucking firm engaged to load and move the rig. In both cases, the ropes were Form-Set (preformed) to insure good spooling and resistance to kinking.

Bethlehem Steel Company, Bethlehem, Pa. On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

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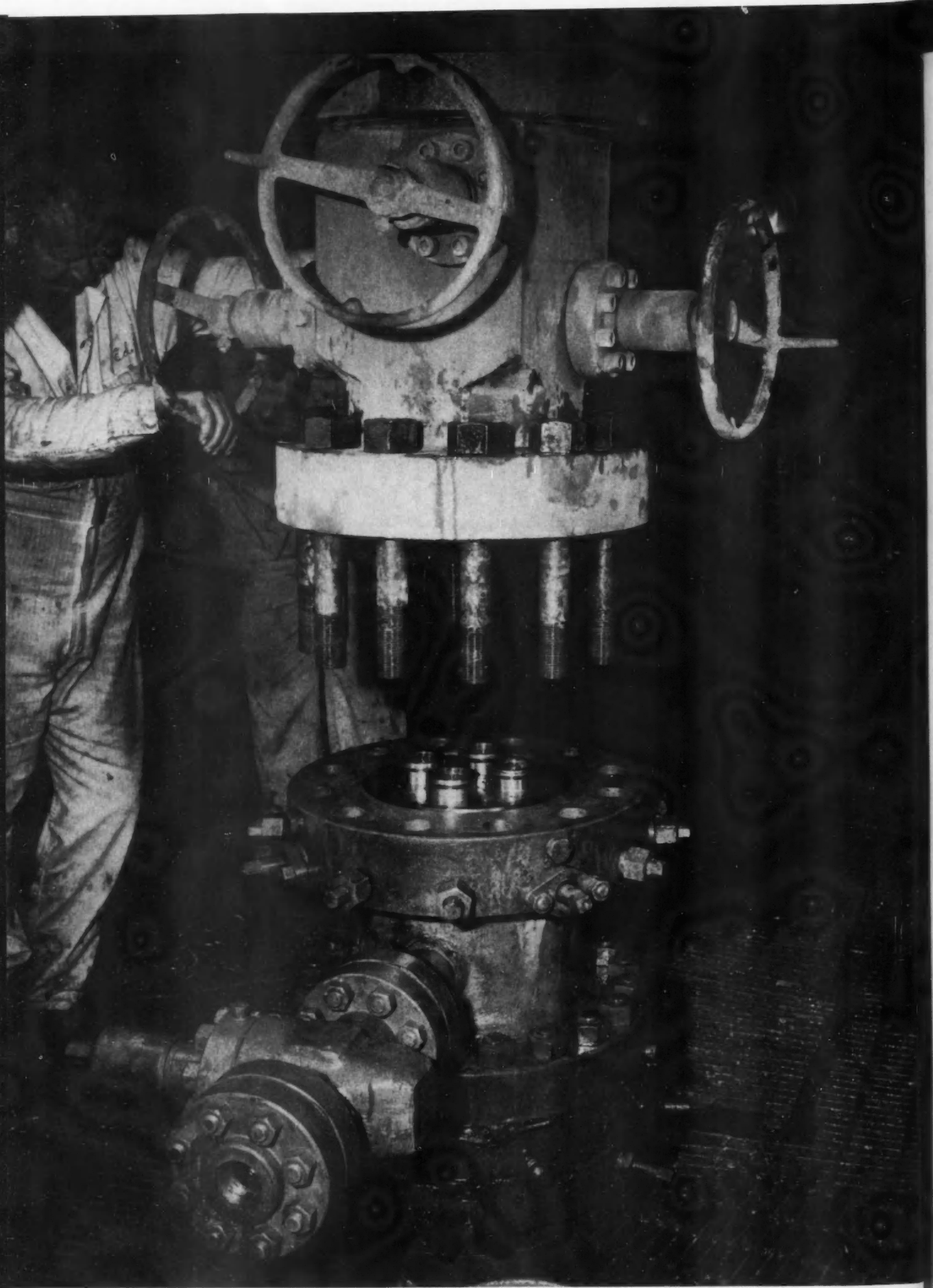

FIGURE 1—This quadruple tubing hanger arrangement was used in the CATC completion. All four strings of tubing have been landed in the quadruple tubing hanger and the tree is being installed.

Approximately 35,000 feet of tubing were required for . . .

CATC's quadruple string completion

This unique completion is the industry's first multiple installation utilizing four parallel strings of 2⅜-inch O.D. tubing. Four excellent oil wells were obtained from a single, deviated bore hole by use of the method.

By W. W. Poimboeuf, District Engineer, and
Robert Henderson, Production Engineer,
The Continental Oil Company, Harvey, La.

THE CATC GROUP* recently completed a quadruple string multiple well installation using four parallel strings of 2⅜-inch O.D. tubing. The unique completion method was used in a deviated hole located in the West Delta Block 30 Field, 12 miles off the coast of Louisiana in the Gulf of Mexico. The quadruple installation should prove economically advantageous since four excellent oil wells have been obtained by drilling a single hole. The expense of additional tubular goods and special equipment required for the project should be more than offset by the increased allowable available from the four producing zones.

A quadruple completion using four strings of tubing first was considered after several triple-string completions had been installed successfully and economically for the CATC Group. During the initial planning stages, it was concluded that a candidate for a quadruple completion should have the following characteristics: The producing zones should be relatively close together. The four zones should show promise of a long producing life. The wells should show a possibility of a long-flowing life so artificial life or rework would not be necessary during early productive stages.

CATC's West Delta Block 45, Well C-8 satisfied these requirements. The well was directionally drilled a distance of 1,326 feet from the surface location from a self-contained drilling platform.

Initial preparation. The quadruple tree used in this installation was constructed from a single-forged steel block and equipped with four dual sets of master valves. The tree was API Series 1500 with a 10-inch tubing head flange. The tubing hanger was split in four 90-degree segments of a circle.

Packers are set individually by sealing off each respective tubing string with a bakelite ball and applying pressure to the tubing. Differential pressure in excess of 4,000 psi shears the pins, sets the slips and collapses the sealing element. A criss-cross thread safety joint was recommended for use on the long tubing string immediately below each packer. This recommendation was made due to the possibility of being unable to rotate the long tubing string through all packers.

Packers are released by rotating the long string. Design of this equipment facilitates the running of all connecting strings below the quadruple packer with the long tubing string. All packers were run on the No. 1 string.

Special unions were incorporated on the bottom of the quadruple and triple packers to tie the second and third connecting strings into the packers. A pressure-actuated, collet-type stinger latch was designed specifically for this installation. This was necessary because of the possibility of pumping the second and/or third string connecting stinger out of the packers during setting operations.

Stingers for the second, third and fourth strings for the quadruple packer were J-type latches. This equipment was tested prior to the completion.

While completion preparations

*The CATC Group consists of Continental Oil Company, The Atlantic Refining Company, Tidewater Oil Company and Cities Service Production Company. Conoco is operator for the group.

'... increased allowable will more than offset additional costs'

were being conducted on Well C-8, the packers were assembled and spaced out in the operator's warehouse yard. Tubing used to space out the packers was color coded and shipped to location. A considerable amount of rig time was saved since it was not necessary to space out the packers while they were being run in the hole.

Completion operations. The well was plugged back to 9,820 feet inside the 9⅝-inch casing. Since mud has a tendency to set up behind packers when it is exposed to high bottom hole temperatures, it was decided to displace the mud system with a more stable completion fluid. All of the completion zones were new sands, and exact bottom hole pressures were unknown. Therefore, it was decided to drill stem test the lower zone to determine the maximum bottom hole pressure that would be encountered.

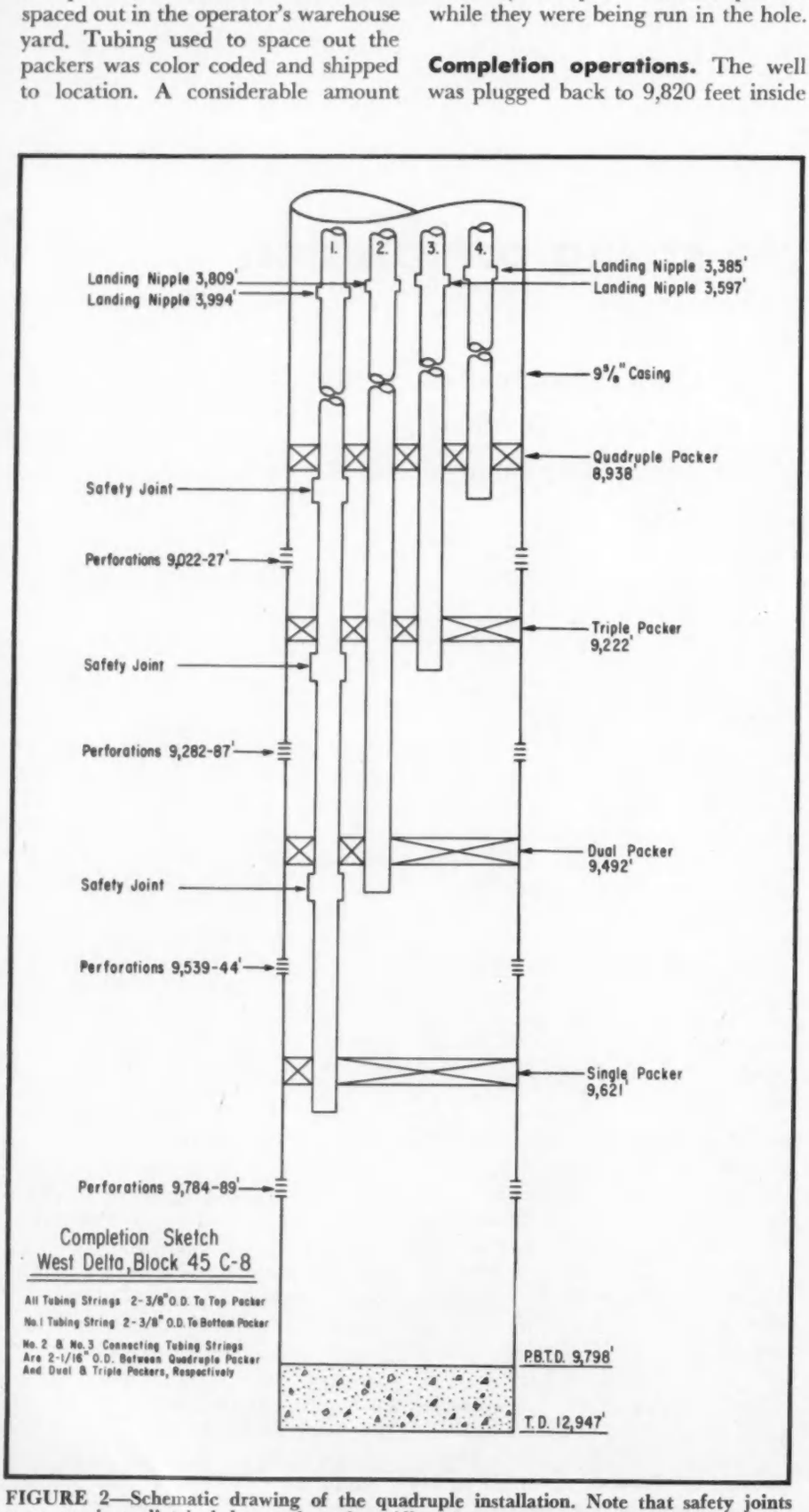

FIGURE 2—Schematic drawing of the quadruple installation. Note that safety joints were run immediately below each packer. All packers were run on the "long" string of tubing.

A 2-foot section in the bottom of the lower zone (9,808 feet-9,810 feet) was perforated with four jet shots per foot and a drill stem test was taken. The bottom hole static pressure was determined to be 5,755 psi. Indications were that a 12.2 pounds per gallon completion fluid would be adequate. This fluid would allow a 300 psi overbalance at 9,500 feet TVD. The perforations 9,808 feet-9,810 feet then were squeezed off with 200 sacks of slo-set cement.

To insure a good primary cement job and to prevent water channeling from the numerous water-bearing sand stringers scattered throughout the interval that included the productive zones, each producing zone was block squeezed beginning with the bottom zone. A 2-foot section was perforated in the vicinity of each producing zone, and a block squeeze was performed with 200 sacks of slo-set cement. Cement was drilled out and a dry test was taken on each set of squeeze perforations with the exception of the lower set. This set was left plugged.

After a dry test had been obtained on each set of squeeze perforations, the mud system was displaced with fresh water. The water was weighted to 12.2 pounds per gallon with sodium nitrate and calcium chloride, using a one-to-two ratio by weight of the respective materials.

Considerable trouble had been experienced in this field with sand incursion. Due to the sanding condition, it was decided to perforate only a five-foot section of each producing zone and squeeze each zone with sand consolidation plastic. It was felt this would partially eliminate the possibility of an early workover job. This procedure was followed.

The single and dual packers were run in the hole on the long string of tubing to the point where the triple packer was to be installed. The 2⅜-inch O.D. long string was hung in dual tubing slips and the 2$\frac{1}{16}$-inch O.D. second string connecting tubing was run and stabbed into the dual packer. The triple packer then was made up on the No. 1 string and the No. 2 string was tied to the packer with a union. This equipment was lowered on the No. 1 string to a point where the quadruple packer was to be installed.

The No. 1 string again was hung in the dual slips and the 2$\frac{1}{16}$-inch O.D. No. 2 connecting string was run and stabbed into the proper port in the triple packer. The No. 1 string was then hung in the elevators and the No. 2 string was clamped off on the drive bushings. The 2$\frac{1}{16}$-inch O.D. No. 3 connecting string then was run and stabbed into the third port of the triple packer.

It should be noted that the proper port for these strings was designated by the stringer size, the second port being larger than the third. The quadruple packer was made up on the long string and the 2$\frac{1}{16}$-inch O.D. Nos. 2 and 3 connecting strings were unioned to the packer. All this equipment was run in the hole to the predetermined depth on the No. 1 string and landed in the tubing head.

A latch-type stringer was made up on the second string and run in the hole. Some difficulty was encountered in stabbing the stringer into the proper port in the quadruple packer, even though the second string port was larger than the third and fourth string ports. After failing to stab the stringer in the quadruple packer, the No. 2 string was pulled. To avoid idle rig time while waiting on a new stringer for the second string, the third and fourth strings were run to 6,500 feet and hung. The new stringer was then installed on the second string and it was run. It should be noted that all tubing used was 2⅜-inch O.D. except that portion of Strings No. 2 and 3 below the quadruple packer. These connecting strings were 2$\frac{1}{16}$-inch O.D.

Due to excessive drag in the directional hole, it was necessary to add 2 feet to the original pipe measurements to get enough weight to force the stinger into the packer. The No. 3 string also had to be overspaced to get enough weight to stab into the quadruple packer. It was then stabbed without difficulty. Attempts to stab the No. 4 string in the quadruple packer were unsuccessful.

After working the No. 4 string for a considerable time, the blowout preventers were picked up and a 2-foot section was added to the No. 1 string. This was done to eliminate the suspected bow in the No. 2 and No. 3 strings. After adding the 2-foot section to the No. 1 string, the No. 4 string was stabbed without difficulty.

The christmas tree then was installed, and reverse circulation was established through all four tubing strings to be sure there were no obstructions in the tubing. The packers then were set in reverse numerical order. A 1⅝-inch bakelite ball was pumped down the No. 4 string to the seating point. The setting pressure was built up to 5,000 psi and the casing was pressured to 1,200 psi to test the packer.

The setting ball was reversed out of the No. 4 tubing string by pumping down the No. 3 tubing string. The No. 3 and No. 2 packers were set in the same manner. The No. 3 packer was tested by placing 1,000 psi pressure on the No. 4 tubing string and the No. 2 packer was tested by placing 1,000 psi pressure on the No. 3 tubing string. The No. 1 packer was set by pumping a 1¾-inch ball down the No. 1 tubing string and building up approximately 5,000 psi setting pressure.

The No. 1 packer was tested with 1,000 psi by pumping down the No. 2 string. The ball was flowed out of the No. 1 string when the well was brought in.

The wells were swabbed in and tested. Results of the tests are shown in Table 1.

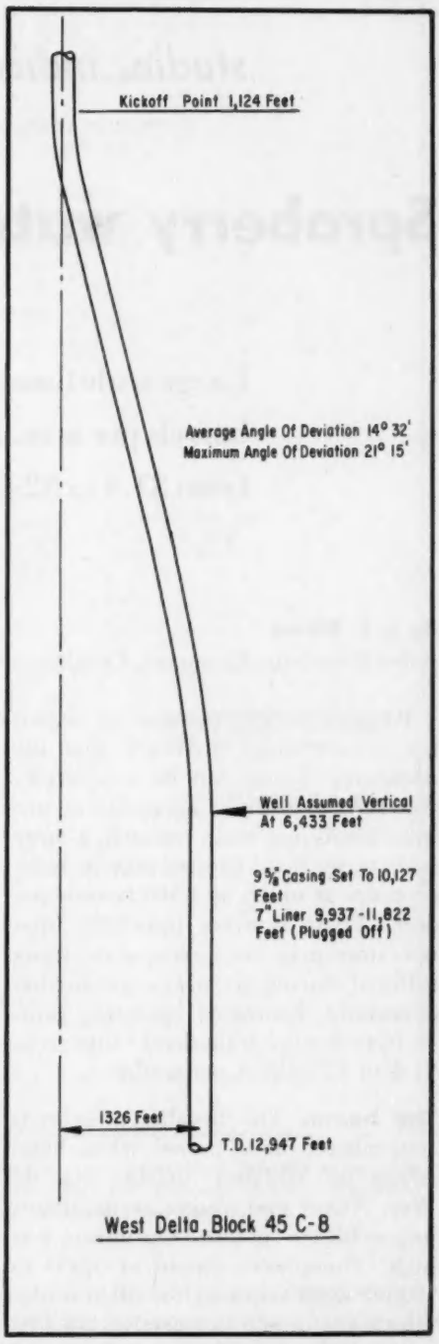
Kickoff Point 1,124 Feet
Average Angle Of Deviation 14° 32'
Maximum Angle Of Deviation 21° 15'
Well Assumed Vertical
At 6,433 Feet
9⅝" Casing Set To 10,127 Feet
7" Liner 9,937-11,822 Feet (Plugged Off)
1326 Feet
T.D. 12,947 Feet
West Delta, Block 45 C-8

FIGURE 3—This schematic drawing shows the deviated hole of the quadruple completion. A cement plug was set at 9,798 feet prior to the completion.

TABLE 1—Test Results

ZONE	Perforations	BOPD	[redacted] FTP	GOR	Gravity	BS&W
C-8	9784-89	300	1750	317	27.8	.1%
C-8D	9539-44	287	2250	523	32.2	.1%
C-8T	9282-87	296	2450	540	29.8	.1%
C-8Q	9022-27	241	2400	528	29.0	.1%

Conclusions. It is believed that the increased allowable provided by the successful quadruple completion will more than offset the additional costs of the well. The actual running operation was speeded up considerably by spacing out the packers and marking the tubing prior to shipment to the location. It is felt that this is a necessary step that must be taken in such a completion to avoid excessive rig time and confusion. **—The End**

studies indicate . . .

Spraberry water-flood will be profitable

Large scale flood may increase recovery up to 1,500 barrels per acre. Estimated profits range from $1.4 to $2 million per section.

By L. F. Elkins
Sohio Petroleum Company, Oklahoma City

RECENT INVESTIGATIONS by several major companies indicate that the Spraberry Trend can be successfully water-flooded. Based on results of two pilot floods and basic research, a large scale water-flood project may increase recovery as much as 1,500 barrels per acre. There is every indication that operators may even recuperate losses suffered during primary production operations. Estimated operating profits from a large scale flood range from $1.4 to $2 million per section.

The boom. The Spraberry boom is remembered as a period when hotel rooms in Midland, drilling rigs in West Texas and casing were almost impossible to obtain. Optimism was high. There were visions of 5,000 to 10,000 wells required for 40-acre development of the prospective 200,000 to 400,000 productive acres indicated by intergrowth of the various Spraberry fields.

Estimated recoveries ranged up to 10,000 barrels per acre based on sustained productivity of early wells and the presence of open fractures in many cores. More conservative operators talked in terms of 2,500 to 3,500 barrels per acre. During 1951 drilling activity increased from only a few early scattered wells to a maximum of 235 active rotary rigs. Nearly 200 wells were completed during December, 1951.

Optimism waned to pessimism when wells in the more fully developed areas began precipitate decline in production and gas-oil ratios skyrocketed within a few months after completion. Drilling declined considerably during the last half of 1952 and reached a low of ten wells completed in November, 1952. Spraberry was dubbed the "Largest Non-Commercial Oil Field Ever Discovered". Some suggested a large sign be erected in the Spraberry Trend—"Opened by Mistake."

Development has proceeded at a moderate pace ever since, with each well more carefully evaluated in light of actual reservoir conditions rather than those previously hoped for. Fortunately, the unusual characteristics of the producing formation and uncertainties of reservoir performance were recognized early enough to encourage many operators to perform the extensive field tests and research necessary for proper interpretation and thus better guidance of remaining development. These same analyses and field tests have led to probable water-flooding of the Spraberry.

Through actual field pilot test, the Spraberry has every indication of being highly profitable, even to the extent of making up losses many operators suffered during primary production operations.

Reservoir data. The Spraberry is a 1,000-foot section of sands and shales of lower Permian age occurring at an average depth of about 7,000 feet. Principal pay sections are an upper sand (about 30 feet thick) productive over most of the field and a lower sand (about 25 feet thick) productive over part of the field. Some lesser sands just a few feet thick produce in local areas.

All Spraberry sands are very tight — less than one millidarcy — and would not produce at commercial rates if the formation were not highly fractured in an extensive interconnected vertical fracture system covering the entire field. These fractures are evident in nearly all cores recovered.

Extent of these fractures is almost unbelievable as proved by reduced pressures observed in new wells at distances up to 1 or 2 miles from previously producing wells and by results of pilot water-floods. The time lag of pressure and production decline in shut-in wells a quarter to one-half mile from producing wells is only a few weeks.

Observation of these pressure and production effects at these distances in closely controlled field tests led the Texas Railroad Commission to change regulations from 40-acre spacing. The commission authorized development and granted allowables on the basis of 80-160 acres per well after December, 1952. Most of the drilling since that time has been on these wider spacings. The wisdom of the move is reflected in the relative payout position of these wider spaced wells compared to more closely spaced wells previously drilled. Since December, 1952, many

ACKNOWLEDGMENT
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internal locations have been left undrilled (See Figure 1).

Cumulative production of the Spraberry Trend area has totaled 150 million barrels. Production rate declined to 42,900 barrels per day in December, 1957. Field performance history is summarized in Figure 2.

The 60 percent decline of fieldwide production over five years from the 107,000-bpd peak in October, 1952, is deceptive. This decline has been retarded by moderate but continuous development of an additional 1,000 wells during this period. Individual wells and leases have declined more nearly 30 to 75 percent per year. Production now averages only 19 barrels per well per day, and many wells and leases produce little or no oil. Some 185 wells have been abandoned and 260 others plugged back to the Clearfork.

It is almost a certainty that many more would have been plugged if it were not for the pending water-flood. More than 500 more wells are off production.

These very low production rates keynote the need for early action in unitizing large areas for water-flooding. If unitization cannot be accomplished within the next year or so, many leases scattered throughout the area will become uneconomic and the wells plugged. If this occurs, waterflooding the Spraberry will likely become only a passing dream and all owners, working interest and royalty interest alike, will be the losers.

Core data and reservoir performance indicate oil in place to be of the order of 6,000 barrels per acre in the Upper Spraberry and perhaps half that much in the lower Spraberry. Actual values are indeterminate since methods have not been developed to really identify the "net" producing pay section. Cumulative recovery av-averages only 500 barrels per acre which is only 6 to 8 percent of oil in place.

Reservoir engineers think this unusually low percentage recovery is caused by capillary retentive forces—blotter action—accentuated by the large number of naturally occurring fractures in this low permeability sand. The fractures were a mixed blessing. On one hand they permitted production from a reservoir too tight to produce if the oil were required to flow through the rock matrix to the wells. In the other case, the fractures

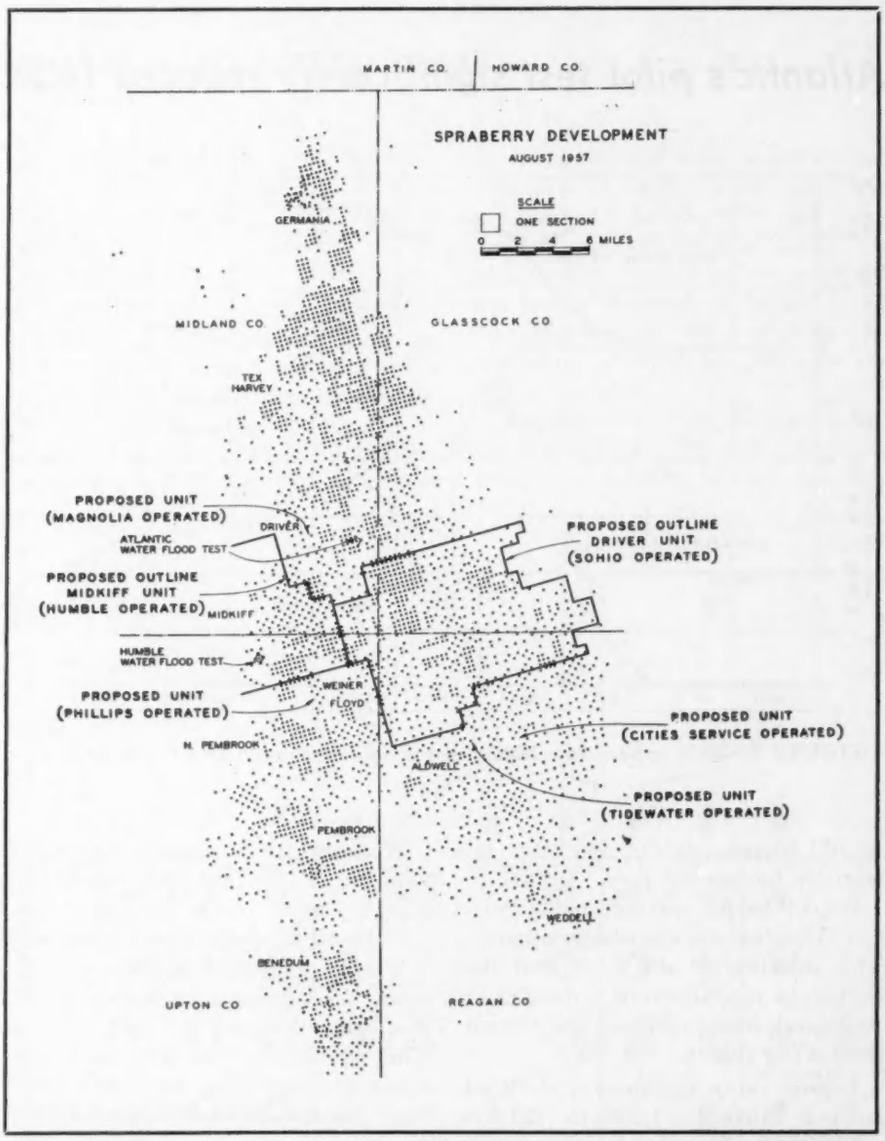

FIGURE 1—The developed area of the Spraberry now approaches 305,000 acres with approximately 3,225 wells variably spaced on 40-, 80-, and 160-acre density. Proposed water-flood units under consideration by major companies are shown.

modified capillary forces to restrict primary recovery to perhaps a third of what it might have been in an unfractured sand having higher permeability.

Reservoir engineers recognized the important features of the Spraberry reservoir performance and the probability of very low primary recovery less than a year after development was accelerated in 1951. Conventional approaches of increasing recovery by gas or water injection did not appear promising to most engineers and operators. It was thought that rapid channeling of injected fluids from the input to producing wells would occur through the open fractures.

The Atlantic Refining Company research engineers, using their background of basic research on effects of capillary forces on displacement of oil from porous media by water injection, visualized a new approach to waterflooding tight fractured sands such as the Spraberry. Simple laboratory tests showed the blotter action of the sand would preferentially absorb water to the extent of displacing a reasonable fraction of the oil out of the sand. Calculations indicated the process would work in the reservoir and Atlantic's management backed this faith with a field pilot test in the central Driver area.

Atlantic's pilot flood. Starting in November, 1952, water was injected into three wells (Figure 3) which comprised part of a normal five-spot pattern. Injection rates reached 650

Atlantic's pilot test significantly reduced GORs

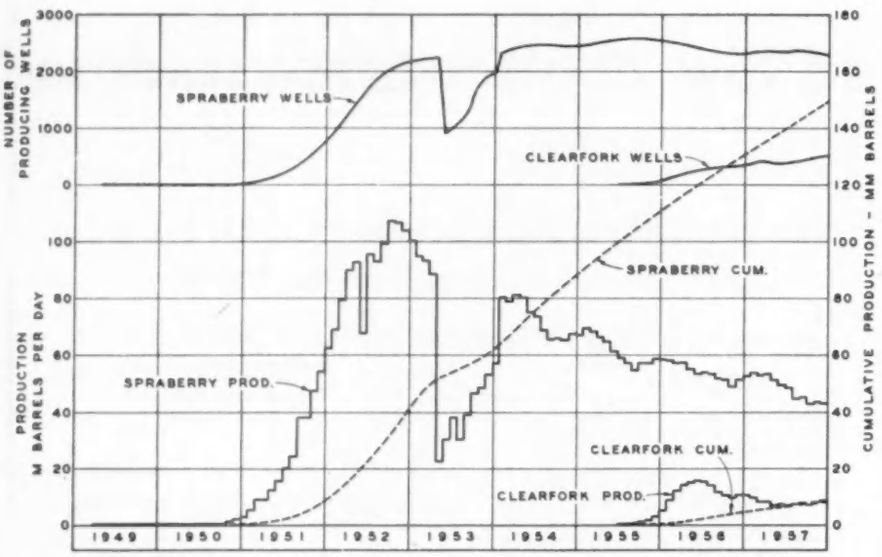

FIGURE 2—Field performance history of the Spraberry trend area is summarized.

to 700 barrels per well per day—essentially by gravity flow. A total of 1,477,000 barrels was injected by Aug. 1, 1955, when the test was terminated. This injection of water arrested the decline in production of a number of wells and increased oil production from a few others.

Gas-oil ratios significantly declined from a range of 4,000 to 125,000 cubic feet per barrel to less than 2,000 cubic feet per barrel in 18 wells in a northeast-southwest trend from the injection wells. These low ratios contrasted sharply with gas-oil ratios of 10,000 to 300,000 cubic feet per barrel in nearby wells northwest and southeast of the trend, during the test period.

Injected water appeared in modest quantities in 11 producing wells and in large volume in only one producing well during the test. Water production conformed closely to the pattern of greatly reduced gas-oil ratios. Together, they outline an approximate 1,000-acre area presumed to have been significantly affected by water injection. Injection totaled 1 million barrels by mid-September, 1954, and ultimately, 1.4 million barrels. This is a volume of 900 to 1400 barrels per acre, respectively. This contrasts sharply with the estimated 50 to 100 barrels per acre fracture volume.

However, it compares favorably with the 1,100 to 1,300 barrels per acre gas space in the formation created by oil production and shrinkage.

This volumetric comparison indicates beyond any reasonable doubt that water entered the rock matrix. The significant reductions in gas-oil ratios indicate the fractures must have become highly resaturated with oil.

Figure 4 outlines the composite performance of 15 wells most affected by water injection and 10 other test wells judged to be unaffected. Following a 75 percent decline in production during the last nine months of 1952, the affected wells stabilized at 200 to 300 bopd in 1953, and the first half of 1954. Composite gas-oil ratio declined from 10,000 to 20,000 to 2,000 cubic feet per barrel.

The most significant production increase occurred in Magnolia Bowles 2, a southwest diagonal offset to two injection wells. This well increased from about 30 bopd to approximately 60 bopd in six months. Significant water breakthrough occurred in only one well—Magnolia Bowles 4. This well rapidly changed from 40-70 bopd and 100-130 bwpd in June, 1953. Flush production of only a few thousand barrels of oil was realized before water entry. Unaffected wells stabilized at about 10 bopd per well following the Spraberry shut-in of April, 1953. They declined rapidly during 1954, when production of all wells in the area was resumed.

Test Interpretation. The generalized interpretation of the Atlantic test results indicate water entered the tight matrix readily and displaced oil into the fractures. The test failed to demonstrate the economic feasibility of waterflooding since well production rates achieved were typically 2-16 bopd per well with few exceptions. This was during 1954, after one to two years water injection. Gas-oil ratios of affected wells were at their mininmum values and the effects of Spraberry shut-in had diminished by that time.

Through analysis of the interrelations of production rates, water injection rates and reservoir and well pressures of the Atlantic test furnishes what may be the real key to the declining natural productive capacity of Spraberry wells. It may also explain why significant production rates were not achieved in this water-flood test. It is believed that the Spraberry fracture openings are pressure sensitive, particularly those near the well bore which have been modified by frac treatment. When reservoir pressure is reduced, the fractures tend to close and restrict production rate. When reservoir pressure is increased, they tend to open and permit high injection and production rates.

As an example, the three Atlantic wells used for water injection had initial potentials of 42 to 134 bopd. These wells had declined to 7 to 20 bopd shortly before water injection started. Each of these wells took about 700 bwpd by gravity. Total oil and gas produced in the vicinity of the Atlantic test considerably exceeded the 2;100 barrels water injected daily. For this reason, reservoir pressure continued to decline in every producing well measured.

It is believed the fractures continued to contract, minimizing oil production rate increases even though the fractures became highly re-satu-

Humble's pilot flood provided encouraging results

rated with oil (indicated by the greatly reduced gas-oil ratios).

It is believed that significant oil production rates would have been achieved if water had been injected into a larger number of wells at rates sufficient to restore the reservoir pressure.

Humble's approach. Starting with the concepts of imbibition water-flooding developed by Atlantic research and benefiting from the Atlantic Spraberry pilot water-flood test, Humble Oil & Refining Company's production Research division extended study of the behavior of flooding fractured reservoirs. The research discovered an additional feature not previously reported in the literature.

Humble's work centered on performance of fractured reservoir blocks as influenced by the dynamic effects of water moving in the fractures. Atlantic's research had involved essentially static water in the fractures. Humble found that strongly water-wet fractured sands could be water-flooded effectively if there were sufficient cross fractures oblique to the general direction of flow. In effect, the various fractured sandstone segments are flooded simultaneously and the oil production from them is additive. There are three requirements essential for successful displacement of oil by this process. They are:

- The formation must be strongly water-wet, it will imbibe water.
- There must be a large number of cross fractures to provide multiple water entry points.
- The fluid flow capacity of fractures in the primary direction of flow (relative to the fluid flow capacity of the rock) must be low enough to permit all the water to enter the matrix of the fractured sand blocks in a considerably less distance than the spacing between injection and producing wells.

Midkiff area flood. Humble began a pilot test in the Midkiff area in March, 1955, using wells as outlined in Figure 5. The center test producing well was newly drilled in this somewhat depleted part of the field. Its productivity declined rapidly from 377 bopd in January, 1955, (following a large frac treatment) to 70 bopd in March, 1955, when water injection started. Gas-oil ratios increased to approximately 8,000 to 10,000 cubic feet per barrel by March, 1955. Detailed performance of this well is illustrated in Figure 6.

Injection of 1,500 barrels water per day into each of the four wells surrounding the test well caused a rapid reduction of GOR to 700 cubic feet per barrel by August, 1955. The production rate stabilized at a rate exceeding the capacity of the pumping equipment installed. A larger pump was installed and oil production remained at 200-250 bpd through the rest of the year.

Variable production during the first few months of 1956 was caused by tests determining which injection

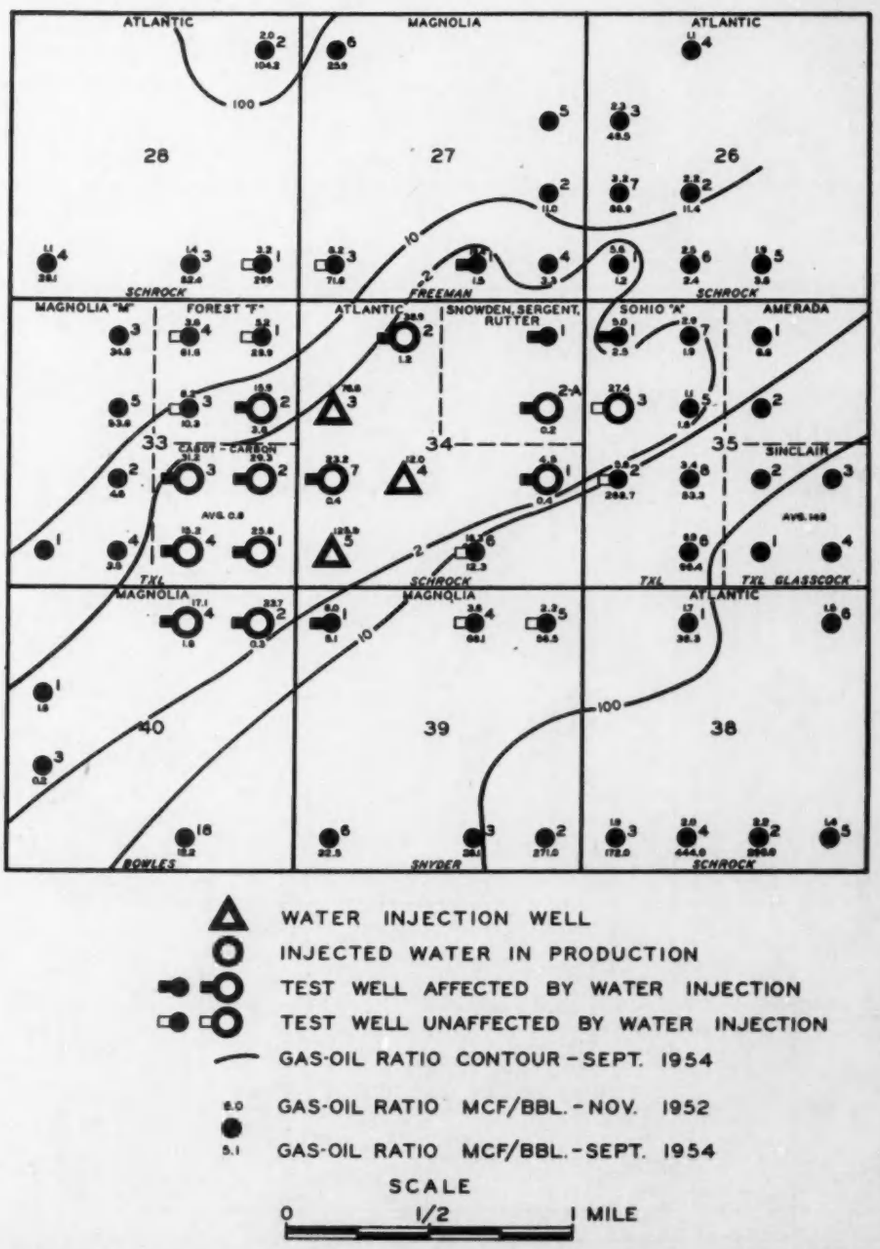

FIGURE 3—The Atlantic Refining Company's pilot water-flood project. Note considerable GOR reduction in producing wells on a northeast-southwest trend from the water injection wells.

wells had the greatest effect on water production from the test well. Variation was also due to a workover performed to blank off one of the lesser sands thought to carry much of the produced water. These tests showed the east-west injection wells had a greater effect on water production than did the north-south injection wells. Water injection has been largely restricted to the north-south wells.

Oil production has declined from 200 bpd in May, 1956, to about 10 barrels per day at present. Water percentage has continued to increase. Water injection was stopped and the test was terminated in the spring of 1958, when 3.8 million barrels had been injected.

At that time, the center test well had produced 118,000 barrels of oil—nearly 1,500 barrels per acre for the 80-acre pilot test. A large percentage of this recovery is attributable to the water-flood since the well was drilled into the semidepleted area. Remaining primary reserves probably were not more than 100-200 barrels per acre at the time of the well's completion.

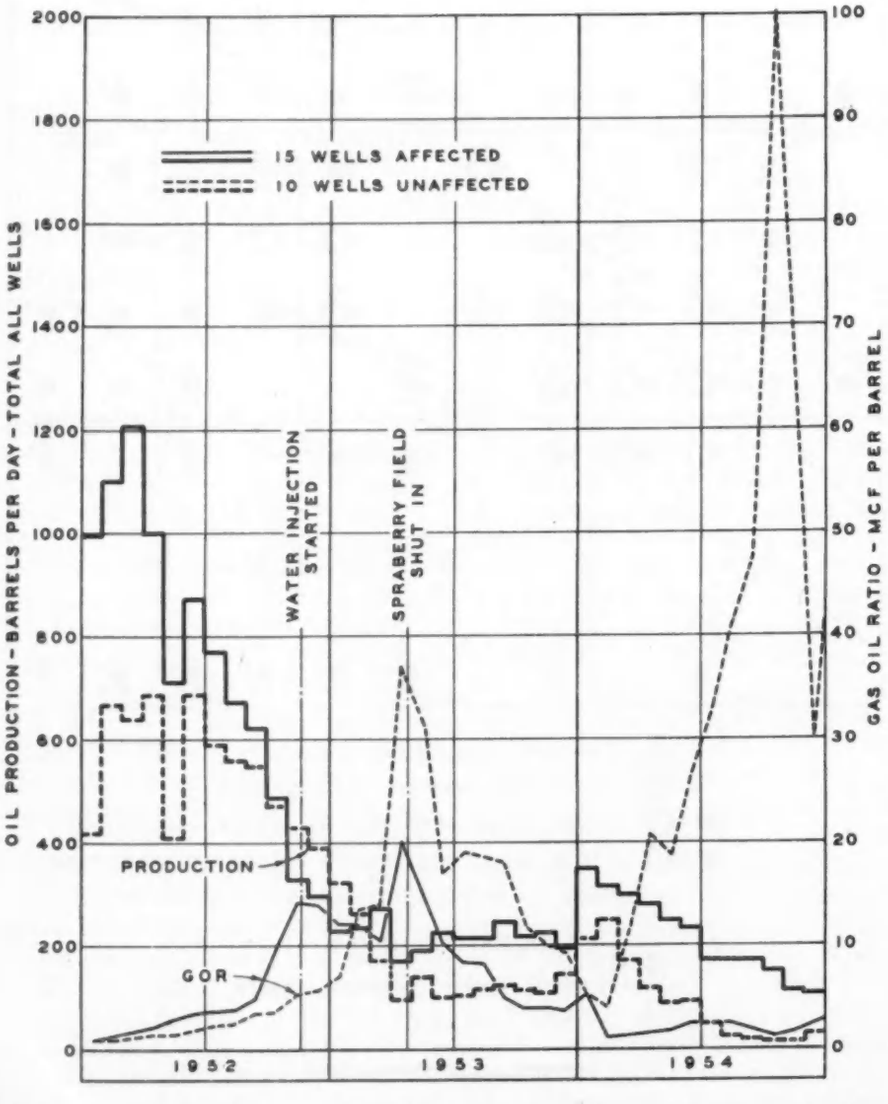

FIGURE 4—Comparative reservoir performance of 15 wells affected by water injection versus 10 wells not affected. These data obtained from the Atlantic water-flood test project.

Contrasts. Increasing oil production to 250 bpd through water-flooding at rates sufficient to restore reservoir pressure is in sharp contrast with the somewhat similar Atlantic field test. The reaction of Humble's test well to pressure restoration is in agreement with the relation between fracture permeability and reservoir pressure previously determined from Atlantic's pilot test data. Gravity injection of 1,500 bwpd into each of the four Humble wells which had initial potentials of only 38-165 bopd, is also in agreement with this principle.

Production data of Humble observation wells outside the pilot five spot also confirm this pressure-production relation. Oil production rates and reservoir pressures of these wells measured before and during the water-flood test are included in Figure 5.

In general, wells northeast and southwest of water injection showed significant increases in production back to 30-50 barrels oil per day. These wells also experienced either stabilization or increase in reservoir pressure. Wells northwest and southeast of injection continued to decline in both oil production rate and reservoir pressure.

Uneven permeability. Invasion of injected water into producing wells—identified by chemical analysis—also was limited to wells in the northeast-southwest trend. The combination of oil production rate increase, reservoir pressure increase and invasion of injected water in this trend indicates the predominant direction of the Spraberry fracture system.

Humble's research engineers have found effective reservoir permeability along the main fracture trend must be assumed to be about 150 times greater than permeability perpendicular to this fracture trend. This value must be considered correct for the calculated times of water breakthrough in the various observation wells to match those actually occurring in the field. This very uneven directional permeability will require detailed study to select wells for water

injection and production. It will require continuous analysis of performance to properly regulate distribution of water injection and production.

It is essential that lines of injection wells conform as nearly as possible to a single fracture or closely associated groups of fractures along the main fracture trend. Similarly, lines of producing wells should conform to other single fractures or closely associated groups of fractures. If injection and producing wells happen to lie in the same major fracture, some direct channeling of water to producing wells will undoubtedly occur. The risk of extreme un-correctible channeling is slight with the freedom to alter injection and production patterns that will come with large scale unit operation. This type of channeling occurred in only one producing well out of 30-50 wells in the two pilot flood tests conducted.

Favorable economic return. Preliminary estimates of operating expense and recovery indicate waterflooding the Spraberry will not support extensive drilling of new wells. It can be highly profitable in areas already completely developed. Indications are favorable that the flood can be effective with wells drilled on 160-acre spacing. It is believed the results of these pilot water-flood tests indicate favorable economic return with extensive flooding of the Spraberry.

The unusual features of flooding created by the directional fracture system make imperative that the operation be conducted as very large scale units. This is necessary to permit proper selection of lines of injection and producing wells over distances of many miles. Large units are also required to permit restoration of reservoir pressure without disproportionate leakage of water from the flooded area to adjacent unflooded areas.

The San Andres formation appears capable of furnishing all necessary water for flooding the entire Spraberry through high capacity supply wells. One San Andres supply well furnished water at rates up to 7,000 bpd for the Humble pilot test without measurable decline in static reservoir pressure during withdrawal of 3.8 million barrels of water. A one day test of Sohio's Davenport B-1, NE NE Section 2, Block 37, T-5-S, yielded 12,000 bwpd with just 45 psi drawdown.

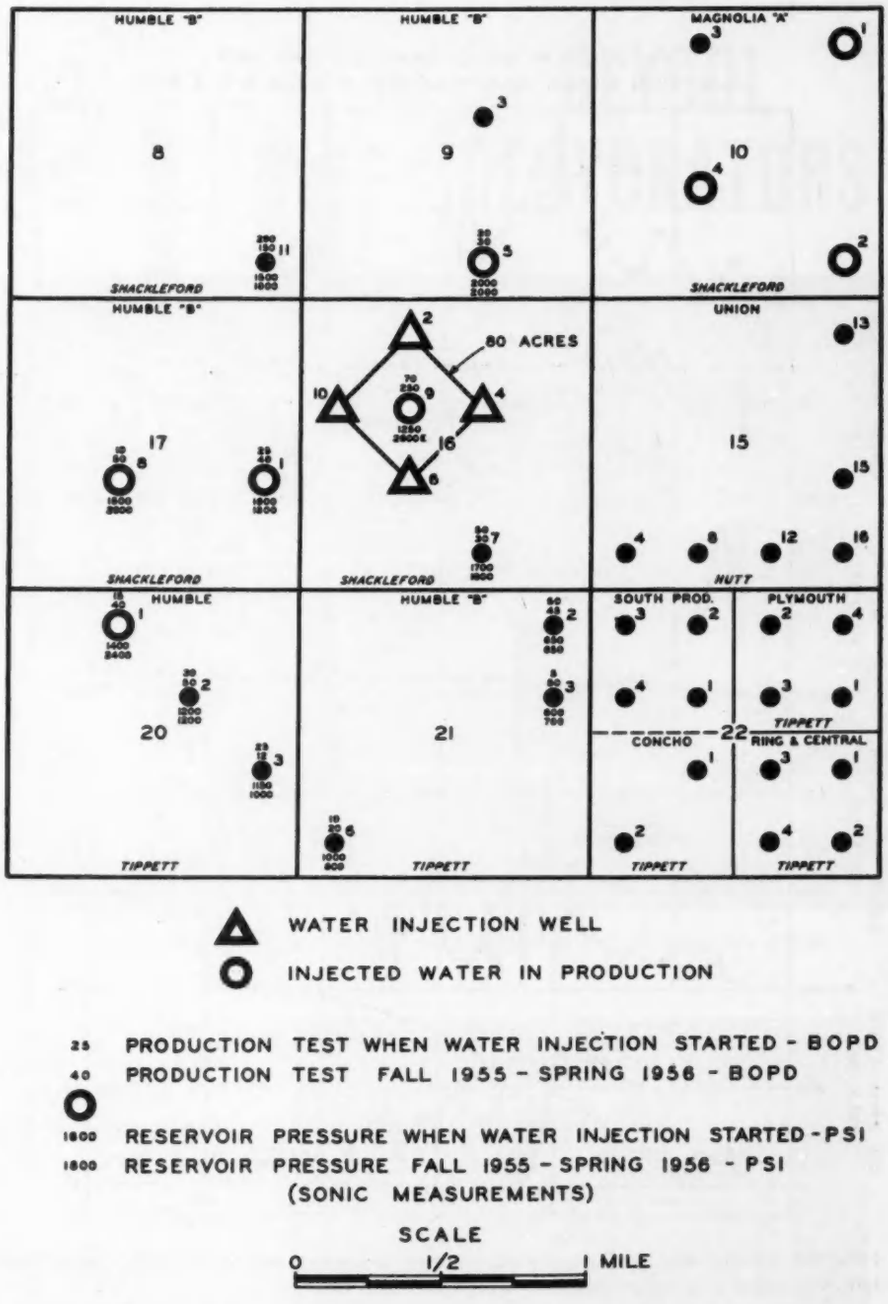

FIGURE 5—Humble Oil & Refining Company's pilot water-flood test. Productivity of newly drilled center test producing well declined approximately 82 percent in two-month period following completion. Water injection restored the well to a profitable rate in short time. As shown, reservoir pressure also responded to the injection program.

Costs. Preliminary studies indicate incremental investment will average $135,000 per section, with flooding on a pattern involving 160-acre spaced wells. These costs assume conversion of many wells to water supply that are in excess of those drilled on 160-acre spacing. It does not include the costs of new wells which may be required in some of the incompletely developed parts of the trend.

Total operating cost including water supply, oil production and all overhead features is estimated to average about $2,500 per section per month when maximum capacity injection and production are achieved. With prospective secondary recovery of 1,500 barrels per acre and these estimates of investment and operating expense, operating profit is forecast to range from $1.4 million to $2 million per section. This is a $10 to $14.50 profit per dollar invested with the

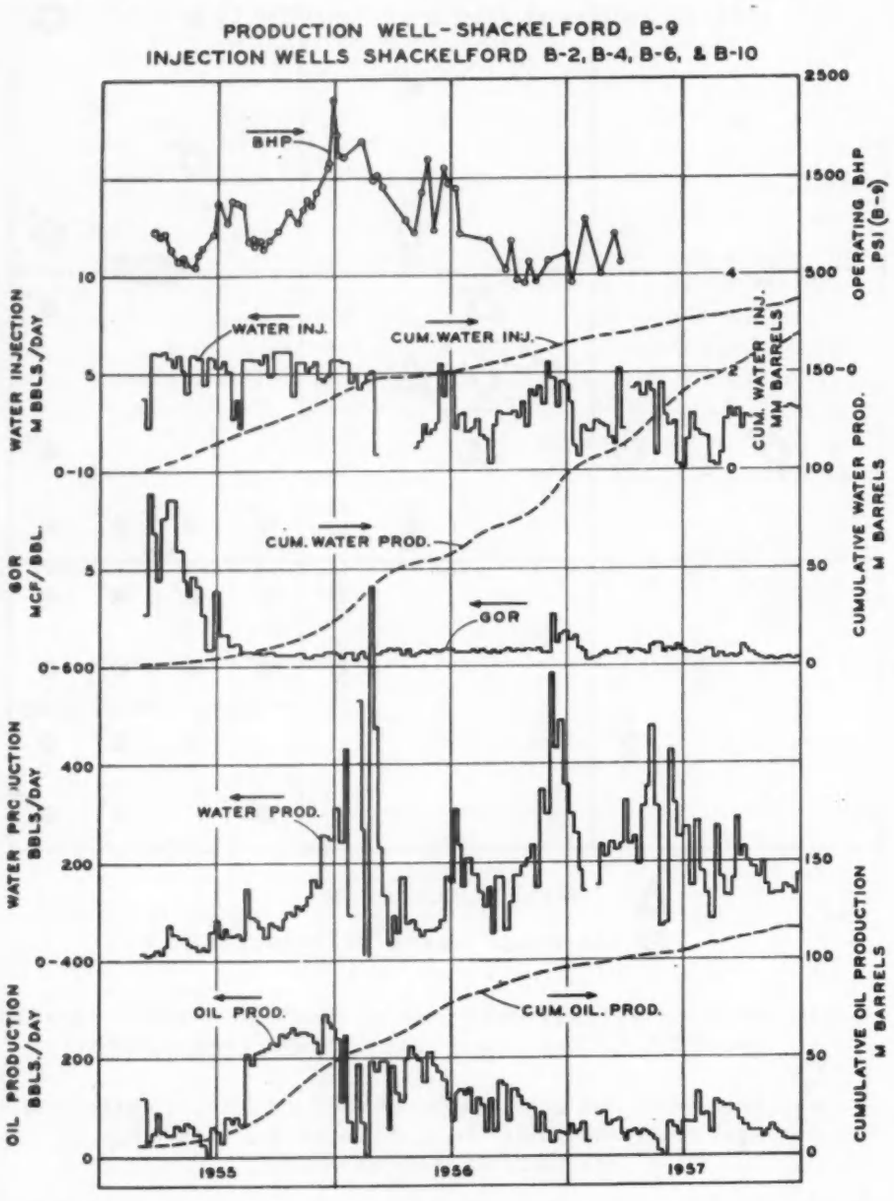

FIGURE 6—Detailed performance of the test producing well in Humble's pilot flood test. Note rapid decrease in GOR following water injection.

range depending upon oil production rates achieved during the flood.

Unitization. Recognizing the pending abandonment of many Spraberry wells approaching the economic limit of operation and having carefully evaluated water-flood prospects, Sohio Petroleum Company undertook the impressive task of attempting unitization of a large part of the Spraberry for water-flooding. Operators of properties within many miles of Sohio's 21 section Driver area lease block were invited to a meeting in Midland, Texas, on Sept. 25, 1957, to hear analyses and proposals. Necessary committees were formed and numerous studies made of the technical, economic, business and legal questions involved.

The progress made in the ensuing eight months has been excellent. Almost 90 percent of working interest owners in a 100-section area have tentatively agreed to unit participation on the basis of surface area. Also, they have tentatively agreed on a basis of deferred adjustment of investment of tangible equipment and required workover costs pending result of a Texas size nine-section "pilot flood." This will be the first phase of water-flood development.

It is hoped that preparation of the unit and operating agreements can be accomplished within the next few months so that they can be submitted to royalty and working interest owners as soon as possible.

The tentative boundary of this unit is outlined in Figure 1. Many additional large Spraberry water-flood units may be organized. One of these, west and northwest of the Sohio section, is being sponsored by Humble Oil & Refining Company. The first meeting of operators in that area was held April 22, 1958.

Many other operators have indicated a desire to organize and operate units in other areas contiguous with the proposed Sohio unit. These include Cities Service Oil Company to the southeast, Tidewater Oil Company to the south, Phillips Petroleum Company to the southwest and Magnolia Petroleum Company to the northwest. While none of these latter unitization efforts has reached the organizational stage, it is likely that most will be formed and the Spraberry flooded.

Summary. A review of the performance of the Spraberry formation during primary production phases and water-flooding (exemplified by two field pilot tests) has been presented. The primary recovery, averaging only 500 barrels per acre, is only 6-8 percent of oil in place. Water-flooding may increase this by 1,500 barrels per acre, if performed on a large scale basis.

Considerable progress has been made toward organizing at least two large Spraberry water-flood units. The few remaining features of unitization probably will soon be resolved such that unit agreements and operating agreements can be submitted to royalty owners and working interest owners.

The pressing necessity of early action cannot be over-emphasized, since so many leases are at or near the economic limit of primary operation. If too many wells are plugged, the field will never be redrilled and waterflooded, and all owners—royalty and working interest alike—will be the losers. —**The End**

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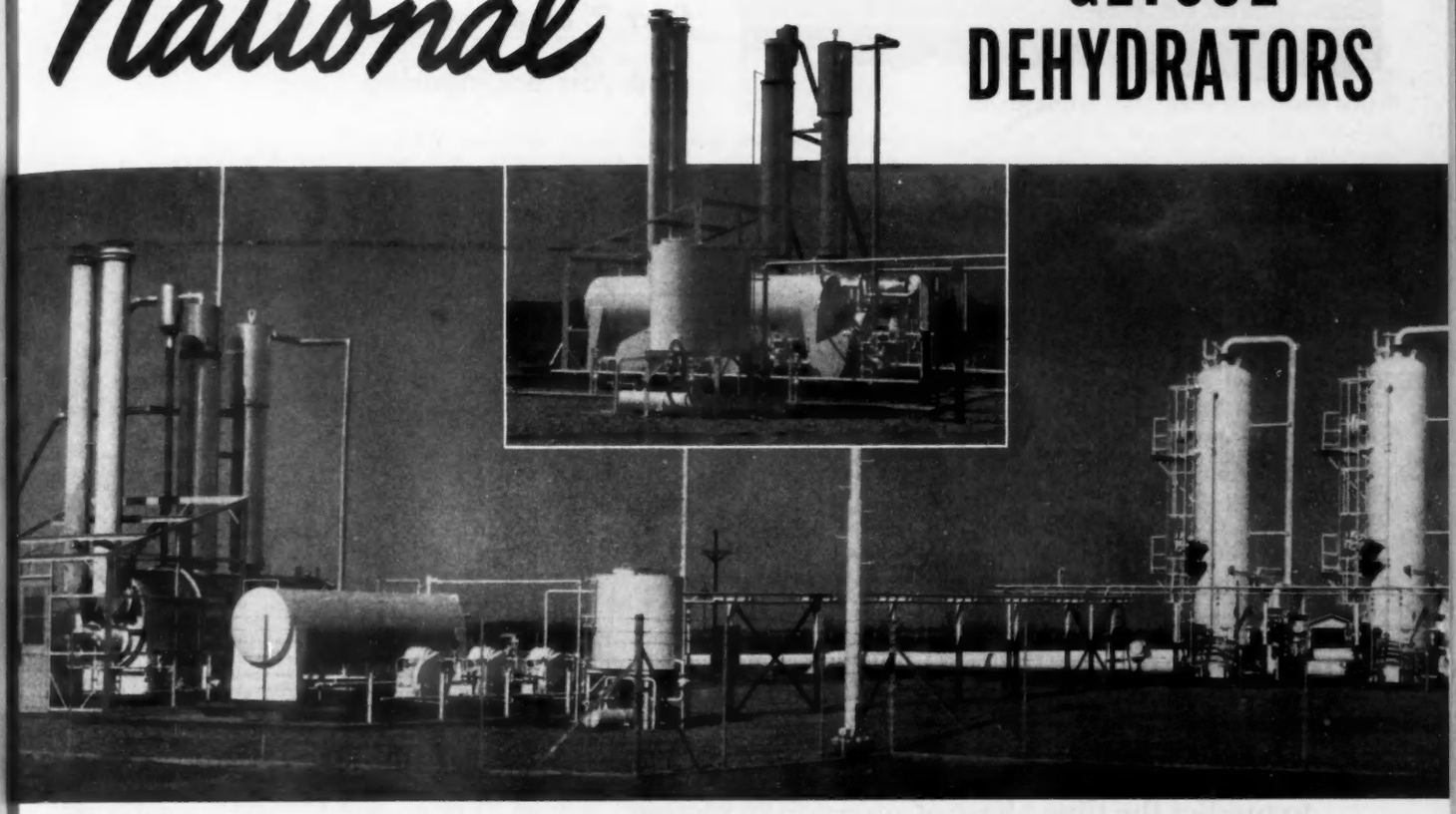

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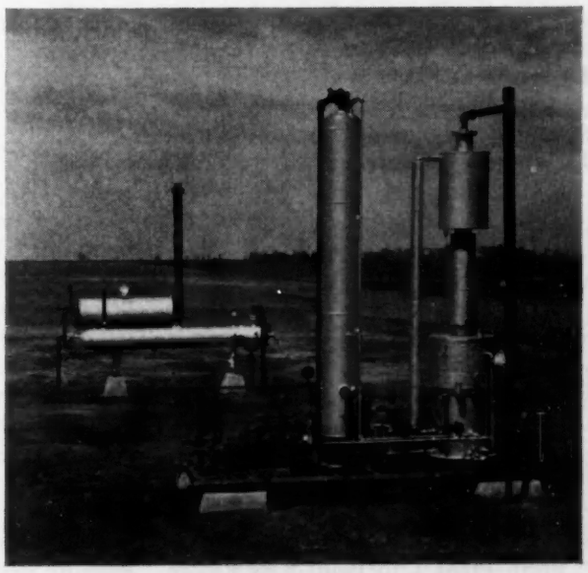

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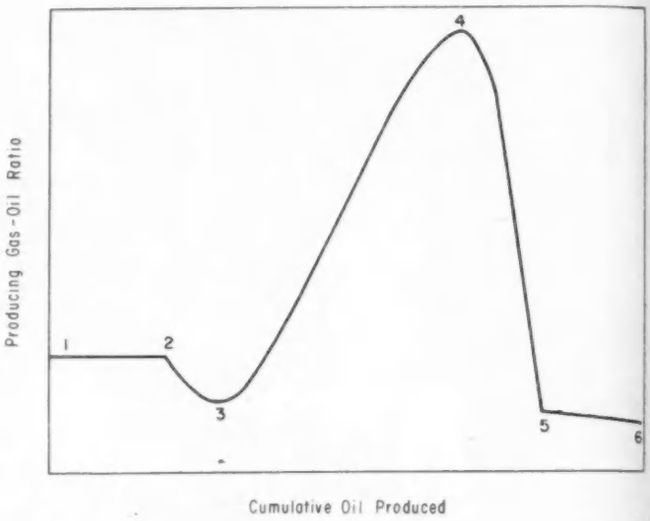
GOR history of a depletion drive reservoir



Gas-oil ratio curve can be used to predict the time phase of reservoir depletion.

By Frank W. Cole
Assistant Professor Petroleum Engineering
School of Petroleum Engineering
University of Oklahoma, Norman, Okla.

THE PRODUCING gas-oil ratio history of a depletion drive reservoir can provide valuable reservoir engineering information when this information is analyzed in the light of the events which must occur in the reservoir. Figure 1 shows the gas-oil ratio history of a theoretical depletion drive reservoir. The changes in the GOR history have been exaggerated to more clearly illustrate the underlying reasons for the changes.

From Point 1 to Point 2 in Figure 1, reservoir pressure is above the saturation pressure, therefore, there can be no change in the solution gas-oil ratio or the producing gas-oil ratio. At Point 2 the reservoir saturation pressure is reached, and gas is evolved from solution. However, this free gas cannot flow until a free gas saturation equivalent to the equilibrium gas saturation (minimum gas saturation necessary to permit gas flow) has been built up. Therefore, the surface gas-oil ratio will begin to decrease, still being exactly equal to the solution gas-oil ratio at the reservoir pressure.

At Point 3 the equilibrium gas saturation is reached, and free gas now begins to flow. The gas-oil ratio increases from Point 3 to Point 4. The rapidity of the gas-oil ratio increase will depend upon the rate of pressure decline. The more rapid the rate of pressure decline, the more rapid will be the increase in producing gas-oil ratio because the sole source of gas is that evolved from solution from the oil. The gas-oil ratio increases because gas is being evolved from all of the oil in the reservoir, while only a small part of this oil is being produced.

At Point 4 the maximum gas-oil ratio is reached for the simple reason that the supply of gas has reached a maximum and the "blow-down" cycle is beginning. From Point 4 to Point 5, the free gas saturation is being depleted rapidly due to the small amount of gas coming out of solution compared to that gas produced.

At Point 5 all of the producible free gas has been produced (in other words, the gas saturation has now been reduced to the equilibrium gas saturation), and the producing gas-oil ratio now is equal to the solution gas-oil ratio, which now is small due to the low reservoir pressure. This same cycle continues from Point 5 to Point 6.

The line from Point 5 to Point 6 seldom is seen in an actual case because the economic limit usually falls somewhere between point 4 and Point 5.

TO BE CONTINUED

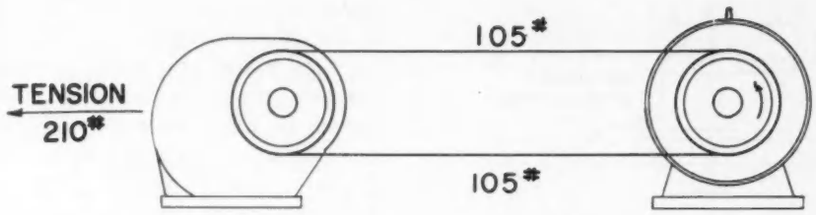


FIGURE 1—A typical drive. 1160 rpm motor drives a machine with a V-belt on 12-inch diameter sheaves with no load. Total tensions of 210 pounds in the belts, and belt speed 3650 feet per minute.

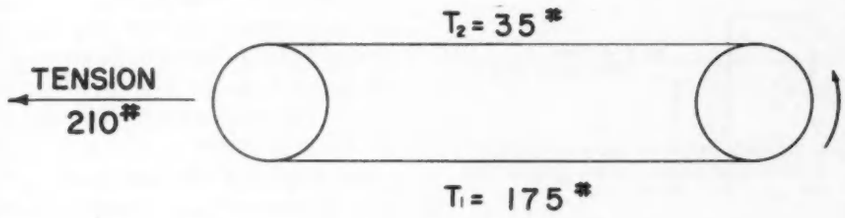


FIGURE 2—A load has been applied to the driven machine until there is a tension of 175 pounds on the tight side, total tension is still 210 pounds, leaving 35 pounds on the slack side of the drive. Tension ratio is now 5 to 1. Net pull and horsepower can now be calculated.

Calculating lowest annual costs for V-belt drive

New data provide a quantitative concept of belt service. Relationship of belt size and quality, load, speed and other factors involved give the engineer a basis for estimating belt life and service.

By Robert A. Vandegrift
The Gates Rubber Company, Denver

AN EXTENSIVE STUDY of the inter-relation of drive service with belt size and quality, load, speed, sheave diameters, etc., has resulted in a rational, quantitative, fatigue concept of belt service. This concept has been used to develop new belt drive design methods which allow the engineer to consider the economic aspects of V-belt drives.

ACKNOWLEDGMENT
This article is based on a paper presented at the West Texas Oil Lifting Short Course, Texas Technological College, Lubbock, Texas, April 11-12, 1957.

The true measure of a V-belt drive is not its horsepower rating, but the service that the drive will give under actual operating conditions. Until recently no data had been published which could be used to predict the relative service life of a V-belt drive. The factors affecting V-belt service and hp capacity have been studied to provide a quantitative measure of their inter-relation. It is possible to analyze any V-belt drive and to predict its relative service based on drive conditions and load that the belts will experience.

When the study of V-belt characteristics was undertaken, the qualitative factors which affect belt life were known. For example, all other factors being equal, belt life is shortened when higher hp is transmitted. The use of smaller-diameter sheaves also shortens the life of a belt; and both belt length and belt speed enter into the calculation of the life and hp rating of a belt.

A major objective was to develop an engineering approach to hp ratings for V-belts.

The results from a number of test programs were used to analyze effects of the various factors which control performance. To illustrate what happens to a belt on a drive, consider a typical drive, Figure 1. The 1160-rpm motor drives a machine with a premium-quality V-belt on 12-inch diameter sheaves. The machines are in motion but carrying no load. The belt tension is 105 pounds in each strand, giving a total tension of 210 pounds in the belts. The motor speed and sheave sizes give the belt a speed of 3650 feet per minute.

In Figure 2 a load has been applied to the driven machine until there is a tension of 175 pounds on the tight side of the belt. The total belt tension is still 210 pounds, leaving 35 pounds on the slack side of the drive. The ratio of the tight-side tension to the slack-side tension is now 5 to 1, which is the value normally used for a V-belt-drive design.

The hp transmitted to the driven machine depends on the difference between the tight- and slack-side tension. In this case, the difference is a net pull of 140 pounds. Using this value and the belt speed of 3650 feet per minute, we see that the belt is transmitting 15.4 hp.

To see what actually happens to the belt in traveling around the drive, we can follow a section as it makes one revolution (Figure 3). The drive is shown at the top left with various positions lettered. The stress diagram at top right shows the pattern of the stresses set up in the cords above the pitch line. (The pitch line is defined as that plane in the belt which is unchanged in length as the belt bends.) Because the belt is moving at 3650 feet per minute, there is a centrifugal force set up which tends to throw the

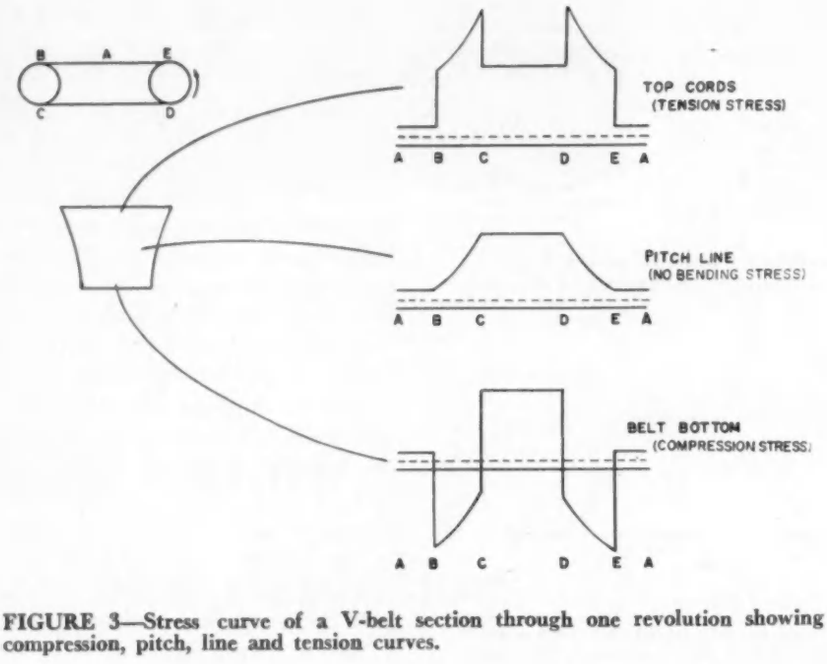


FIGURE 3—Stress curve of a V-belt section through one revolution showing compression, pitch, line and tension curves.

belt away from the sheaves. This force is resisted with an equal but opposite force in strands BE and CD. In the example, this centrifugal force equals 25 pounds at the pitch.

Besides the centrifugal stress, at point A the belt is also subjected to the slack-side stress of 35 pounds. The belt experiences the sum of these two stresses until it reaches point B. At B the belt bends onto the sheave and develops an additional tensile stress in the cords above the pitch line. This bending stress is inversely proportional to the diameter. It is represented in Figure 3 by the vertical stress, T_B. In the example, T_B is equal to 130 pounds. In going from B to C on the sheave, the belt goes from the slack side to the tight side of the drive. At point C, the stress in the belt reaches a peak which is made up of three components: the bending stress of 130 pounds, the tight-side stress of 175 pounds, and the centrifugal stress of 25 pounds. The total peak stress is 330 pounds. Leaving point C, the bending stress is relieved, and the belt travels from C to D under a tension equal to the sum of the tight side plus the centrifugal stress. At point D, the belt again bends onto the sheave and experiences a second peak stress equal to the stress at point C. In going from D to A, the belt reverses the stress cycle experienced in going from A to C.

The peak stress that the belt actually withstands (330 pounds) is considerably more than the tight-side stress of 175 pounds or the net pull of 140 pounds, although these are the two values which are directly related to the hp transmitted.

Other components of the belt also undergo cyclic stress patterns as the belt travels around the drive. Some of these are shown in Figure 4. For example, the bottom of the belt experiences compression instead of tension when the belt is bent onto the sheave. At the pitch line no stress due to bending occurs.

Stress patterns similar to those of Figure 4 could be developed for each of the other components of the belt. But they would only serve to emphasize two important points: (1) Each portion of the belt is subjected to a cyclic stress pattern as it travels around the drive and (2) each portion experiences a peak stress once each time that it travels around the sheave.

A piece of baling wire will break after it has been bent back and forth at the same place. We know that the wire failed in fatigue because of repeated stressing below its ultimate strength. In a similar manner, the components of the V-belt fail in fatigue when subjected to repeated cyclic stress patterns.

From a large number of tests, the relation between the average number of cycles at failure to the value of peak stress has been determined. This relationship may be plotted as a "fatigue" curve. On this diagram, the peak stress of the drive in the example results in an average of 663 million cycles before failure. The shape of this curve is similar to that of the "S-N" fatigue curve for steel. It differs in that an "S-N" curve for most metals has a "knee" at a certain value of peak stress. If the metal is stressed continuously below its critical value, it will not fail in fatigue; but above this value, it will fail at a predictable number of cycles. No such knee has been found in the fatigue curves for V-belts.

A curve such as that in Figure 5

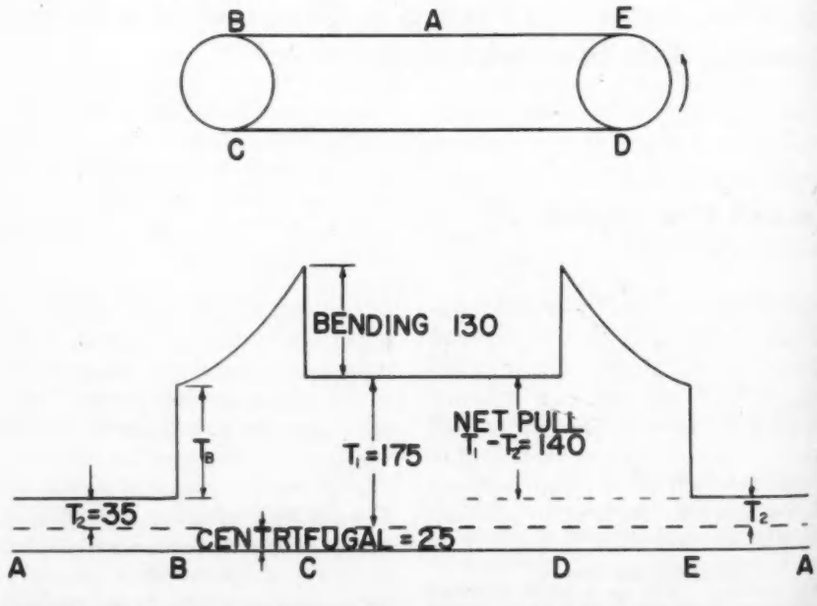


FIGURE 4—Stress curve of the cyclic stresses in a V-belt, showing compression in the bottom of the belt, tension in the top of the belt, and the pitch line of the belt.

allows a prediction of the service life of any drive similar to the one used in the example. From the characteristics of the drive, the tight side (T_1), the bending (T_B), and the centrifugal (T_C) stresses can be computed. From these, total peak stress ($T_1+T_B+T_C$) can be derived. Total peak stress used with the fatigue curve, gives the average number of cycles before belt failure. The number of cycles is related to the length of the belt, to belt speed, to number of sheaves and to the average service given by a V-belt before it fails.

While the peak stress-fatigue life concept is basically quite simple, a number of complicating situations arise on nearly every practical drive. It has been necessary to study ways to reduce the complicating factors to equivalent simple factors. As an example, the stress pattern of Figure 5 assumes a constant hp load. But on a pumping unit it is well known that the load is far from steady. Figure 6 shows the load diagram for one stroke of a pumping unit. The fluctuation of the load is shown as following a sine curve. It is recognized that the actual load seldom follows a smooth curve such as this. However, if a sine curve with a maximum value equivalent to the peak torque derived from a dynamometer card is used, the work area under the sine curve will equal the work done on a balanced well at the same peak torque and will be greater than the actual work if the well is unbalanced. Therefore, when a sine curve based on actual peak load conditions is used for analysis, the results are conservative.

Under fluctuating load conditions shown in Figure 6, the stress pattern experienced by the belt also fluctuates. Figure 7 shows the stress pattern for the example drive of Figures 1 and 2. When no load is transmitted, the belt is subjected to centrifugal stress, bending stress; and the 105 pounds no-load tension. If the number of cycles to failure of the belt is computed from the fatigue curve, based on the peak stress at peak load conditions, the number will be less than the number of cycles of the belt on the given drive. Similarly, the number of cycles predicted from the peak stress under no-load condition would be greater than that of the actual drive.

To relate the actual belt service to the fluctuating load pattern, a method is needed for arriving at an equivalent steady load which will give the same life as that of the actual fluctuating load. To do this, a multiplier called the service factor is used with either the average hp or the peak hp. This will result in steady hp, known as the design hp, which will be equivalent to the actual fluctuating hp. The design hp will be greater than the average hp, but less than the peak hp. Figure 8 shows two methods of arriving at the design hp for an API 57 reducer. We note that either method gives the same results. API Standard 1 calls for the use of the second method, that of multiplying the hp corresponding to the peak torque rating of the reducer of 0.89.

Another complication experienced in applying the simple stress-fatigue concept to actual drives, is that on a typical pumping unit drive, the driving sheave is smaller, with bending stress correspondingly higher, than on the reducer sheave. This means that the peak stresses are no longer equal (as in Figure 5 for the example drive). Finding a way to determine a pair of equal-diameter sheaves which would be equivalent to the unequal diameters of the actual sheaves has become necessary. The diameter

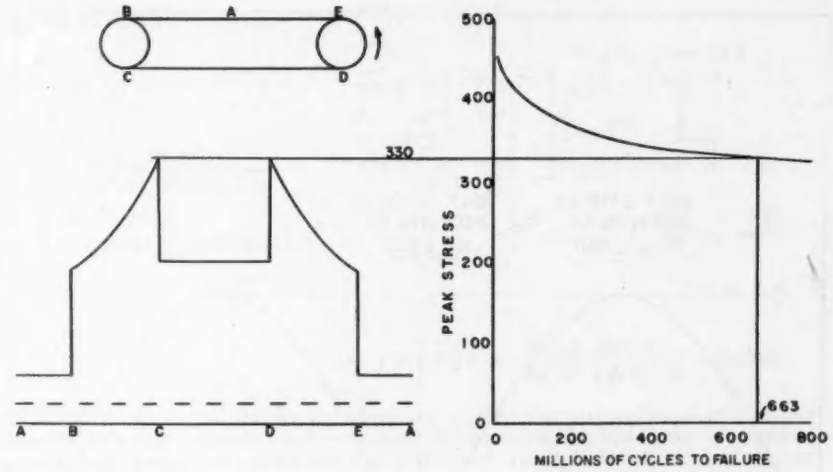


FIGURE 5—Stress curve showing peak stress and the means of predicting service life of any drive similar to Figure 1.

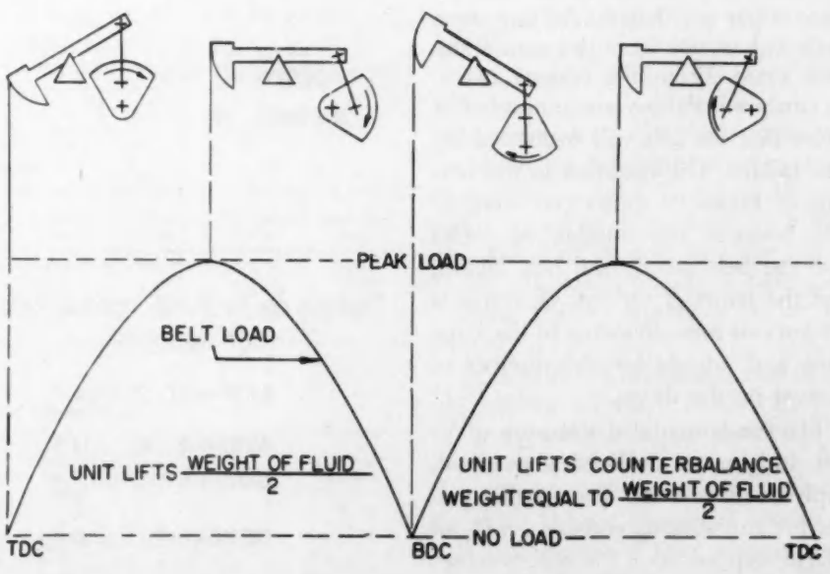


FIGURE 6—Load diagram for one stroke of pumping unit shown fluctuating as a smooth sine curve.

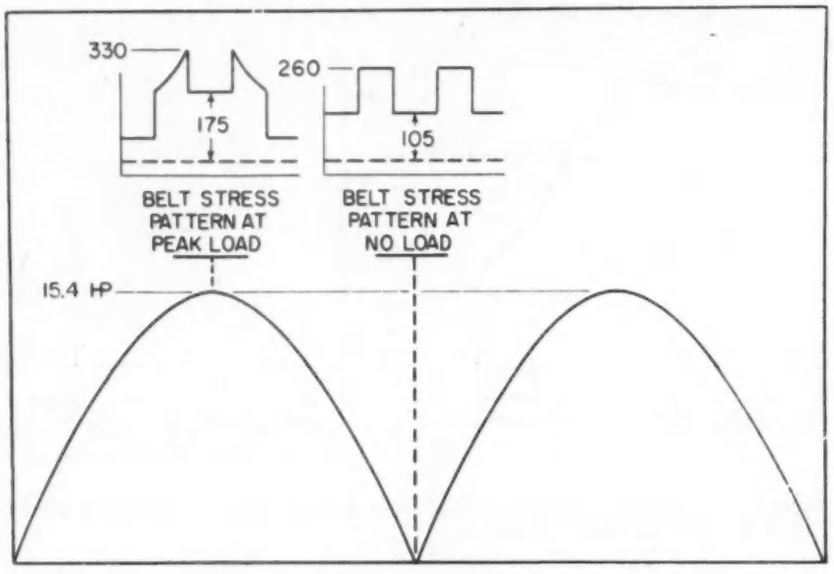


FIGURE 7—Stress pattern for the example drive of Figure 1 and Figure 2, when no load is applied the belt is subjected to centrifugal stress, bending stress, and the 105 no load tension.

of these equivalent sheaves is known as the index diameter.

The stress-fatigue relationships are as shown in Figure 9. The peak stress experienced by the belt is made up of three components: tight-side stress, bending stress and centrifugal stress. The first equation shows that the bending stress is inversely proportional to the index diameter; the second equation shows the relationship between the design hp and the tight-side stress; and the third equation shows that the centrifugal stress is a function of the belt speed squared. In these equations C_1 is related to the thickness and the stiffness of the belt and C_2 is related to the mass of the belt per unit length. Adding these three values, we can determine the peak stress. From the fatigue curve, we can predict the average number of cycles that the belt will withstand before failure. The equation at the bottom of Figure 9 shows the relationship between the number of cycles and the belt speed, the belt length, and the hours of service. C_3 converts the various measurements to the same units and adjusts for the number of sheaves on the drive.

The fundamental mechanism of V-belt fatigue, as outlined above, will apply to all V-belts. The specific values for the various constants will, of course, depend upon the belt, whether standard or premium-quality.

From the stress-fatigue relationship we see that a hp "rating" for a V-belt must state or imply some average service for the belt. There is no such thing as the hp rating for a V-belt. Instead, we could compute any number of ratings, each corresponding to a different fatigue life. Conversely, we could choose any fatigue life and compute a corresponding rating. In order to set up some standard of comparison between drives, the new design method takes the service level of a drive designed exactly to the hp rating of API Standard 1, adopted in 1956, as its standard. Instead of working directly with the fatigue curves, or with their complicated equations, this new method expresses the service level of any drive as a percentage of that standard service given by a drive designed exactly to API standard ratings.

When an engineer sizes a unit to a well, he bases his choice of beam rating and reducer for a pumping unit on a series of assumptions. In so doing, he may occasionally finish up with an oversized or undersized unit. The engineer must also use these assumptions in choosing or analyzing a V-belt drive. Allowing for the usual, unavoidable differences between assumptions the designer must make and the actual conditions with recognition that unpredictable factors in any well may cause even more drastic discrepancies, a service level of 100 percent can be considered to correspond to three to five years' service.

To show some of many ways this new design method can be used, two typical problems have been solved. The first deals with the problem of the most economical drive and the second, with the economics of premium belts versus standard belts on a maintenance replacement basis. (The calculations have been made with data found in recently published manuals[1] and they assume that 100 percent service level corresponds to exactly three years of service.)

We shall assume that an API size 114 pumping unit is to be installed in an electrified field. We shall operate it at 20 strokes per minute. The unit selected has a double reduction

BASED ON AVERAGE TORQUE RATING OF REDUCER	BASED ON PEAK TORQUE RATING OF REDUCER
57 D—20 S./MIN.	57 D—20 S./MIN.
AVERAGE HP.....11.5	PEAK HP.....18.1
SERVICE FACTOR 1.4	SERVICE FACTOR 0.89
DESIGN HP.....16.1	DESIGN HP.....16.1

FIGURE 8—Two methods of arriving at the design horsepower of an API '57 reducer. One method based on average rating and another based on the peak on the torque rating.

gear box and is available at the same cost either with a 4-C-19.25-in.-unit sheave or a 3-C-27.0-in.-unit sheave. The motor speed is 1160 rpm and the center distance is 60 in. Evaluating possible drives for a 10-year period, we raise two questions:

1. What is the lowest first-cost drive?

2. What is the most economical drive?

Since the driven sheave is part of the unit, it is not considered in our cost analysis. Starting with the 19.25-in.-pumping-unit sheave, it is impossible to design a 100 percent service level drive, because 3.6 standard quality C-162 V-belts would be required. Since we cannot put on a fraction of a belt, we shall have to use either three or four belts. The additional belt and groove on the motor sheave will cost $16.15. Is this additional expenditure justified?

Designing the drive with the 27-inch-pumping-unit sheave shows that 3C-180 standard V-belts will give 115 percent service level (about 3½ years). The question is raised, "Will the additional cost of $13.44 to use 3C-180S premium V-belts be justified in actual service?" We wish to know which of the four drives considered will give the lowest cost.

In Table I these four possible solutions have been tabulated. The first five columns give details of each drive and its first cost. On a first-cost basis, the 3C-162 standard V-belt drive would be the cheapest at $60.23. However, the second question of the most economical drive requires a look at service level.

When we consider the first two drives, we see that the 3C-162 standard belts will give a service level of 32 percent or almost one year of service per set of belts. In ten years the drive would need 10.3 sets of belts at an annual cost of $35.96.

However, adding one belt and one groove on the motor sheave (additional cost $16.15) results in a service level of 17 percent (about five years per set of belts). This drive, will show an annual cost of $11.76 or a savings of $24.20 per year (more than $2 per month) over the first drive.

Now we shall consider the second pair of drives. The 3C-180 standard belts will give a service level of 115 percent (about 3½ years) at an annual cost $13.88. Replacing the standard belts with premium-quality belts (additional cost $13.44) results in a service level of over 300 percent. Therefore, 3C-180S premium-quality belts will run the entire ten years at an annual cost of $8.38, an annual savings of $5.50. This is a return of 40 percent on the $13.44 additional investment.

In the comparison of all four drives, the 3C-180S premium-quality belt drive has the lowest annual cost, and will perform the entire ten years, if a 100 percent service level drive would last three years as assumed. This would eliminate downtime costs for belt replacement and lost production, which, while not included in the above analysis, are very real costs.

The costs of lost production may be more than the annual belt replacement cost. For example, consider a well with a 60-barrels-per-day allowable, producing 40°-gravity oil. We assume the following conditions:

1. The company realizes $2.25 per barrel.

2. When the belts fail, the well is shut down for eight hours before the crew arrives to replace the belts.

3. It takes two hours to replace the belts and start again. Under these conditions the company would lose production worth $56.25. Discounted at 6 percent over a well life of 20 years, this means an actual loss of $40.

The second typical problem deals with comparison of annual belt replacement costs. For this comparison we assume a pumping unit operating at 12 spm with a 7-groove 32 inch reducer sheave. The design hp is 62.0 and the unit is now equipped with 7C-180 standard quality V-belts.

Here are the questions to be answered:

1. Would the additional cost of replacing the standard belts with preminum-quality belts be justified over a 10-year period?

2. Could the unit operate with six standard V-belts instead of seven?

A comparison of four possible complements of belts is shown in Table

Continued on Page 116

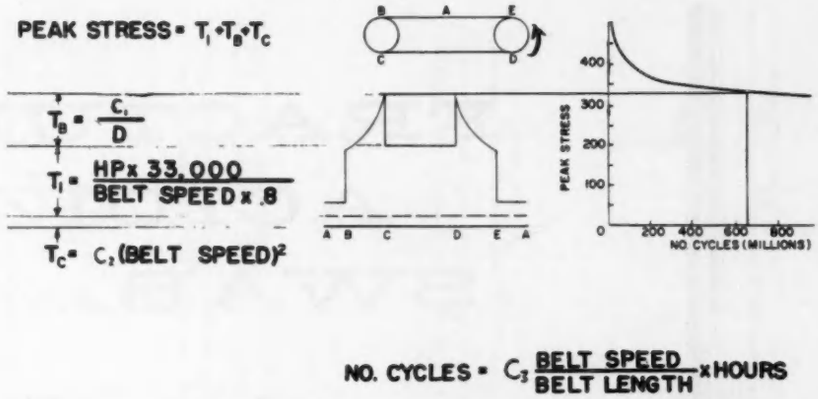


FIGURE 9—From the fatigue curve we can predict the average number of cycles that the belt will withstand before failure. These equations show the relationship between the number of cycles and the belt speed, the belt length, and the hours of service.

TABLE 1
Possible Solutions

UNIT	Sheave	Sheave	Belts	COST	Service Level	Belt Sets	10-Year Cost	Cost Per Year
114D.....	4-C-19.25"	3-C- 9.8"	3C-162	$60.23	32%	10.3	$359.60	$35.96
114D.....	4-C-19.25	4-C- 9.8	4C-162	76.38	170	1.96	117.58	11.76
114D.....	3-C-27.0	3-C-13.0	3C-180	70.35	115	2.90	138.75	13.88
114D.....	3-C-27.0	3-C-13.0	3C-180S	83.79	300+	1.	83.79	8.38

TABLE 2
Annual Replacement Cost Comparison

	7C-180	6C-180	5C-180-S	6C-180-S
Belts per Set.....	$84.00	$72.00	$82.40	$98.88
Cost per Set.....	100%	40%	100%	290%
Service Level.....	3.0	1.2	3.0	8.7
Years of Service*.....	3.3	8.3	3.3	1.15
Sets of Belts in 10 Years.....	$277.20	$597.60	$271.92	$113.71
Total Belt Cost.....	$ 27.72	$ 59.76	$ 27.19	$ 11.37
Annual Belt Cost.....	$ 57.76	$ 48.06	$ 41.47	$ 48.06
Motor Sheave Cost (for comparison).....				

*(Based on 100% = 3 years).

FRACTURE
ACIDIZE
SWAB *and* TEST

as many intervals as required

Product No. 677-C

... *in one round trip*

with BAKER RETRIEVABLE BRIDGE PLUG *and...*

SETS AND PACKS OFF AGAINST PRESSURE DIFFERENTIALS FROM EITHER ABOVE OR BELOW

After the Retrievable Bridge Plug has been run to the desired depth and released, it will automatically set and pack off against pressure differentials established from either above or below the tool.

CAN BE RUN IN AND RETRIEVED EASILY... OR MOVED AND RESET AS MANY TIMES AS REQUIRED

The number of times that the Retrievable Bridge Plug can be released, moved and reset is limited only by the number of operations in the well that require its use.

NUMEROUS ECONOMICAL APPLICATIONS

Used WITH the Baker Full-Bore Retrievable Cementer for:

(a) *Straddle Operations*
The distance to be straddled is not limited by the made-up length of tool.

(b) *MULTIPLE Zone or Selective Testing, Fracturing, Acidizing*

Used BY ITSELF for:

(a) "Down-the-casing" Fracturing or Acidizing

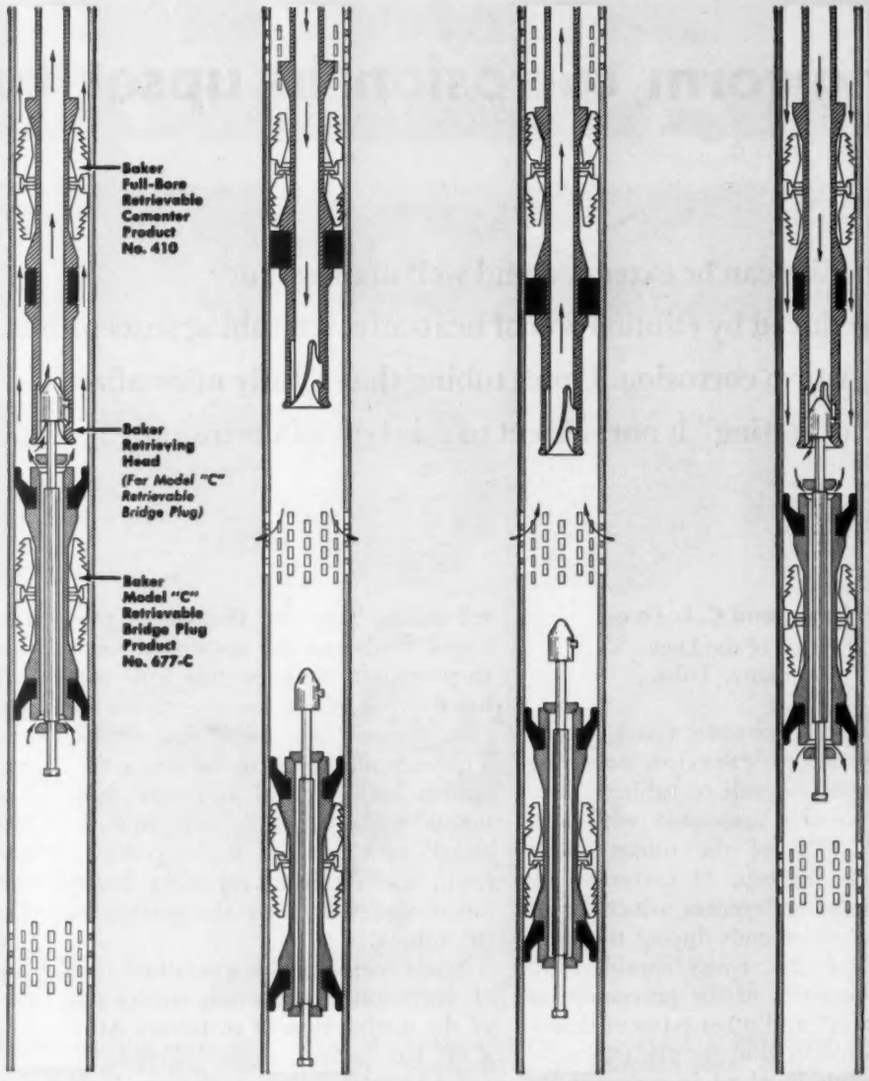
(b) Testing operations

(c) Temporary pressure containment to permit repair to or removal of well head equipment with safety.

Write for Catalog Supplement No. 319 for complete information on

TYPICAL OPERATION

Product No. 410


Baker Full-Bore Retrievable Cementer Product No. 410
Baker Retrieving Head (For Model "C" Retrievable Bridge Plug)
Baker Model "C" Retrievable Bridge Plug Product No. 677-C

RUNNING-IN
Retrievable Bridge Plug being run into well on bottom of Full-Bore Cementer through use of Retrieving Head. Note fluid by-pass.

FRACTURING OR ACIDIZING
Plug should be pressure tested after release. Cementer is released, raised above perforations and reset for pressure operations.

SWABBING, TESTING
Note how the reversal of pressure differential has transferred load from one set of slips to the other (both cementer and plug).

RETRIEVING
Plug and Cementer being moved to next set of perforations—or retrieved from well. Valves in plug open to permit fluid by-pass.

BAKER FULL-BORE RETRIEVABLE CEMENTER

HOLDS PRESSURE FROM EITHER ABOVE OR BELOW

Two sets of opposed slips enable the cementer to hold pressure from either above or below. Casing can be tested before squeeze—and the tubing also, if the Baker Full-Bore Tubing Tester is used.

FULL BORE CONSTRUCTION

Permits Passage of Tubing Perforators or Instruments—Assists in Preventing "Screen-Out" on Fracturing Jobs

The Full Bore through the Cementer (and Tester if used) is in reality a continuation of the bore through the tubing.

This continuous full ID passage not only permits passage of tubing perforators or instruments but assists in preventing "Screen-Out" (sand dropping out of the oil) and subsequent plugging of the tubing in fracturing jobs.

IDEAL STRADDLE TOOL WHEN USED WITH BAKER RETRIEVABLE BRIDGE PLUG

The operation of the Cementer setting mechanism makes it easy (through the use of the Retrievable Bridge Plug Retrieving Head) to release and pick-up the Baker Retrievable Bridge Plug. It is in fact the ideal partner to the Retrievable Bridge Plug for selective multiple-zone or single-zone operations.

these products and their application

BAKER OIL TOOLS, INC.
HOUSTON • LOS ANGELES • NEW YORK

Ringworm corrosion in upset tubing

Tubing life can be extended and well maintenance costs reduced by elimination of heat-affected tubing susceptible to ringworm corrosion. Upset tubing that is fully normalized after "upsetting" is not subject to this type of corrosion.

By J. P. Engle and C. E. Fox
Dowell Division of the Dow Chemical Company, Tulsa

RINGWORM CORROSION is a special type of tubing corrosion occurring near the upset ends of tubing joints. The process is associated with heat affected areas of the tubing. Basic causes of this type of corrosion are temperature differences which occur near the upset ends during the "upsetting" process. Every consideration should be given to the prevention of "ringworm" and other types of downhole corrosion due to the expensive fishing costs involved in recovering a parted string of tubing.

Oil well tubing suffers corrosion in several different forms. These may be generally classified as pitting corrosion, erosion corrosion (also known as the mesa type), stress corrosion involving cracks and breaking, and "ringworm" corrosion.

Pitting corrosion results from localized attack at various points on the tubing surfaces, usually on the exterior. Corrosion within these pits is accelerated so that the pits rapidly penetrate the metal. Resulting metal losses might be insignificant if spread uniformly over the entire tubing; but because they are localized, premature failure results. Occasionally such pits overlap, resulting in thinned areas of pipe wall.

Erosion corrosion usually results from the tubing reacting chemically with well fluids. In gas condensate wells, carbonic acid and organic acids react with steel, forming iron carbonate on tubing surfaces. This is a self-stifling reaction. Passage of produced fluids and the suspended solids they contain dislodge this iron carbonate scale. Fresh metal surfaces are then exposed for additional attack. This continual cycle of carbonate formation and removal gradually thins tubing walls. Because such chemical attack usually tends to be non-uniform, the resulting corrosion leaves mesas and valleys on the surface of the tubing.

Stress corrosion is a specialized type of corrosion that usually grows out of the pitting type of corrosion. After a pit has formed, stresses become localized at that point causing cracking. Some types of metal, such as N80 tubing, are known to be "notch-sensitive" and are especially susceptible to this type of corrosion.

"Ringworm" corrosion is a special type of localized tubing corrosion associated with heat-affected areas or zones. These zones are produced during forging operations in forming the upset ends on tubing. Such corrosion takes the form of a ring or band of pits, sometimes completely circling the tubing, a few inches from the upset end. This circumferential pitting weakens the tubing, and may result in expensive fishing jobs if the weakened tubing should part.

Upsetting oil well tubing is considered desirable so that threads can be cut in the end of the tubing without reducing wall thickness. This minimizes the problem of stress raisers in the threads. The ends of the tubing are usually placed in a furnace and heated to 1,800-2,000°F. They are then placed in a vise and struck a sharp blow. The ends are compressed and the tube walls thickened for threading.

Temperature gradients in the tubing result since only the tube ends are heated. At the tubing end temperature may rise as high as 2,000°F. Temperature may reach only 1,300-1,400°F. a few inches from the end, while the rest of the tubing may not get much above room temperature. These temperature differences are the basic cause of ringworm corrosion. Iron or steel undergoes many changes in microstructure during the upsetting operation. These changes result in a band of heat-affected metal, 4 to 12 inches from the joint end that is highly susceptible to corrosion. When the tubing is placed into service in a corrosive environment preferential attack and pitting take place in this heat-affected zone.

It is impossible to detect such heat-affected areas in new tubing without destructive testing (i.e., cutting a section from the metal and examining it under a metallurgical microscope). It has the appearance of sound metal and reacts similarly to all physical tests. In service it rapidly corrodes, resulting in the phenomenon known as ringworm corrosion.

To understand more fully the mechanism responsible, a knowledge of the metallurgical changes taking place in the metal during heating is important. Normally, from room temperature up to approximately 1,330° F., steel exists in a magnetic form known as ferritic steel. Heating to temperatures below 1,330°F. will have no effect upon the crystal size or crystal structure of the metal. Once 1,330°F. is surpassed, a transformation

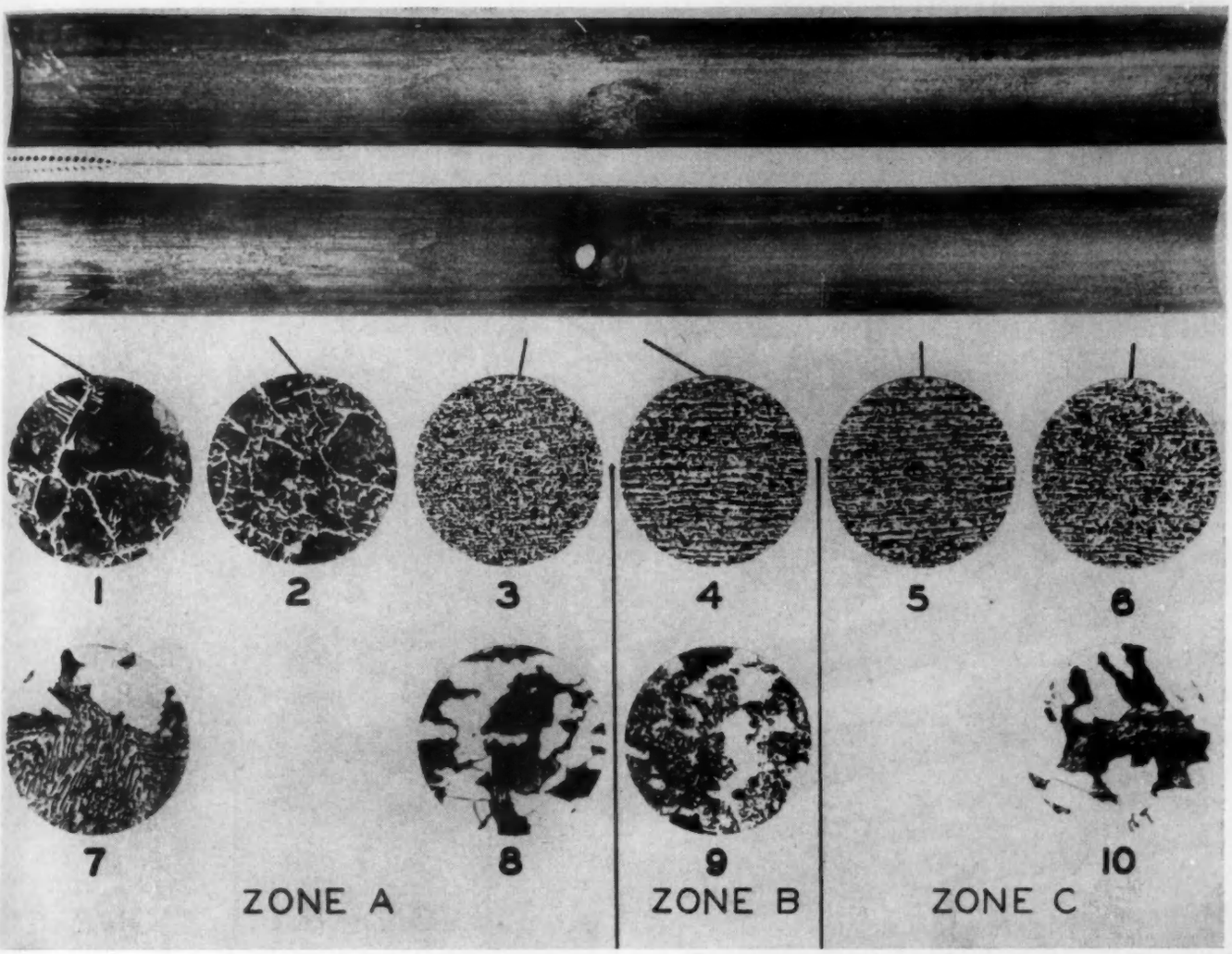


FIGURE 1—A section of tubing suffering internal ringworm corrosion is shown above. Perforation has occurred at one spot even though the remainder of the tube is relatively unharmed. Photomicrographs show crystal structure of the metal at various indicated areas on the tubing. Zone A represents metal heated past the critical temperature during upsetting operations. The crystals have undergone transformation. Photomicrograph 1—(100X). The metal at the end of the tubing where threads were cut was the hottest and remained above transition temperature the longest. This allowed the crystals to grow to a relatively large size. Photomicrograph 7—(1,000X). This photo, at higher magnification, reveals that pearlite is well resolved in this area. Photomicrograph 2—(100X). This metal, a few inches from the end of the tubing, was not heated to as high a temperature as the threaded portion of the tubing and remained above the critical temperature a shorter period of time. The crystal size is accordingly smaller than those shown in Photomicrograph 1. Photomicrographs 3—(100X). Adjacent to the corrosion zone, crystal size is very small. This indicates the metal remained above the transition temperature for a short period so that little grain coarsening occurred. Photomicrograph 8—(100X). This enlargement shows some pearlite resolution. Zone B represents the transition zone where temperatures did not rise sufficiently to produce complete transformation. Photomicrograph 4—(100X). This section shows overall crystal structure similar to the original pipe (Zone C). Photomicrograph 9—(1,000X). This enlargement shows pearlite platelets have broken down and coalesced into droplets or balls. This is known as spherodization. The resulting metal becomes extremely susceptible to operational corrosion. Because this transition zone is limited in area, the resulting corrosion is localized, giving rise to the phenomenon known as "ringworm corrosion."

begins to take place in the steel resulting in a change in crystal structure at 1,475°F.

Iron exists as a body-centered cubic lattice below 1,330°. This might be visualized as a regular six-sided cube with an atom of iron located at each of the eight corners plus an additional atom in the center of the cube, equidistant from the eight corners. Above 1,330°, the iron shifts to a face-centered lattice. This is still a cubical structure with an atom of iron at each of the eight corners of the cube. Instead of an atom at the center of the cube, however, there are now six atoms of iron—one located at each of the six faces of the cube. This shift requires considerable rejuggling of the iron atoms with the resultant destruction of any previous crystal system. A multitude of new microcrystals are formed.

While the temperature remains above the transition temperature of 1,330°, the microcrystals gradually coalesce and join to form larger crystals. This continues slowly so that metal which has been held at high temperatures (well above 1,330° F.) for a long period of time will have a large crystal size. It is understood that the terms small, medium and large size crystals are relative only, since all of them are detectable only under a microscope.

In addition to crystal size, changes in temperature also affect the carbon contained in the steel. At lower temperatures, while the steel is still in a body-centered lattice, there is little room for carbon. As a result only

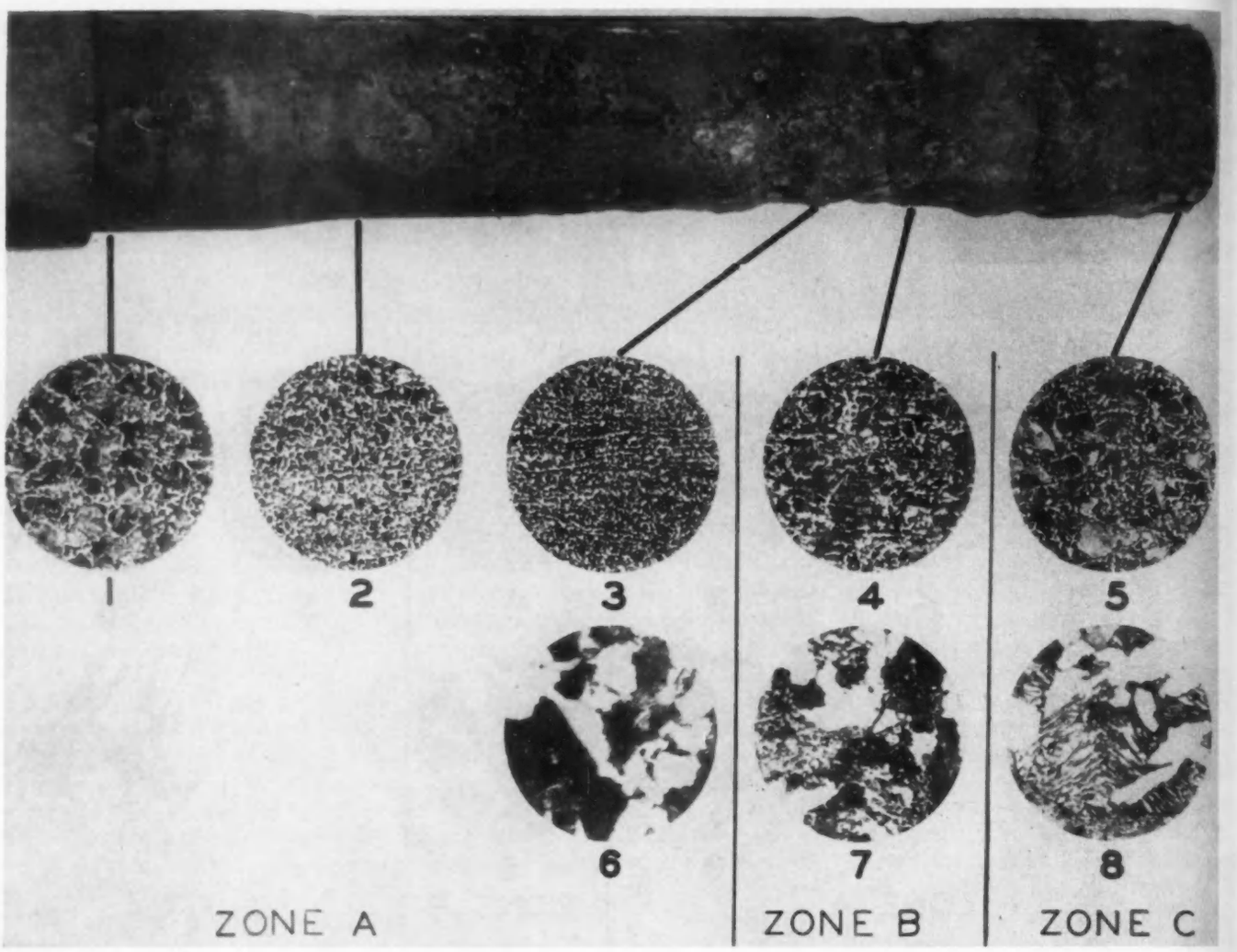


FIGURE 2—This section of oil well tubing has undergone extensive external corrosion. Intensified attack in the susceptible area (transition zone) is observable. Zone A represents metal heated past the critical temperature during upsetting operations. These crystals have undergone transformation. Photomicrograph 1—(100X). This metal was raised to the highest temperature during upsetting. Note the large crystal size due to the relatively long period spent above transition temperature. Photomicrographs 2 and 3—(100X). These sections are also in the heat-affected area of the tubing. Note that the crystal size becomes progressively smaller in the cooler areas of the tubing. Photomicrograph 6—(1,000X). This enlargement shows well-defined pearlite platelets indicating that grain transformation was complete in this area. Zone B is the transition zone which was heated to just under transition temperature. It is the zone which was most susceptible to corrosive attack. Photomicrograph 4—(100X). Crystal conversion was only partial in this section. This area received the intensified attack referred to as ringworm corrosion. Photomicrograph 7—(1,000X). This magnified section shows that the original pearlite has broken down and spheroidization has taken place. Zone C is in the section of pipe which was not heated above transition temperature. The original crystal structure of the metal was unaffected. Photomicrograph 5—(100X). This picture shows the original crystal structure of the tubing. It was unaffected by the upsetting operation. Photomicrograph 8—(1,000X). This enlarged view shows well defined lamellar pearlite indicating this area of the pipe should exhibit normal corrosion resistance.

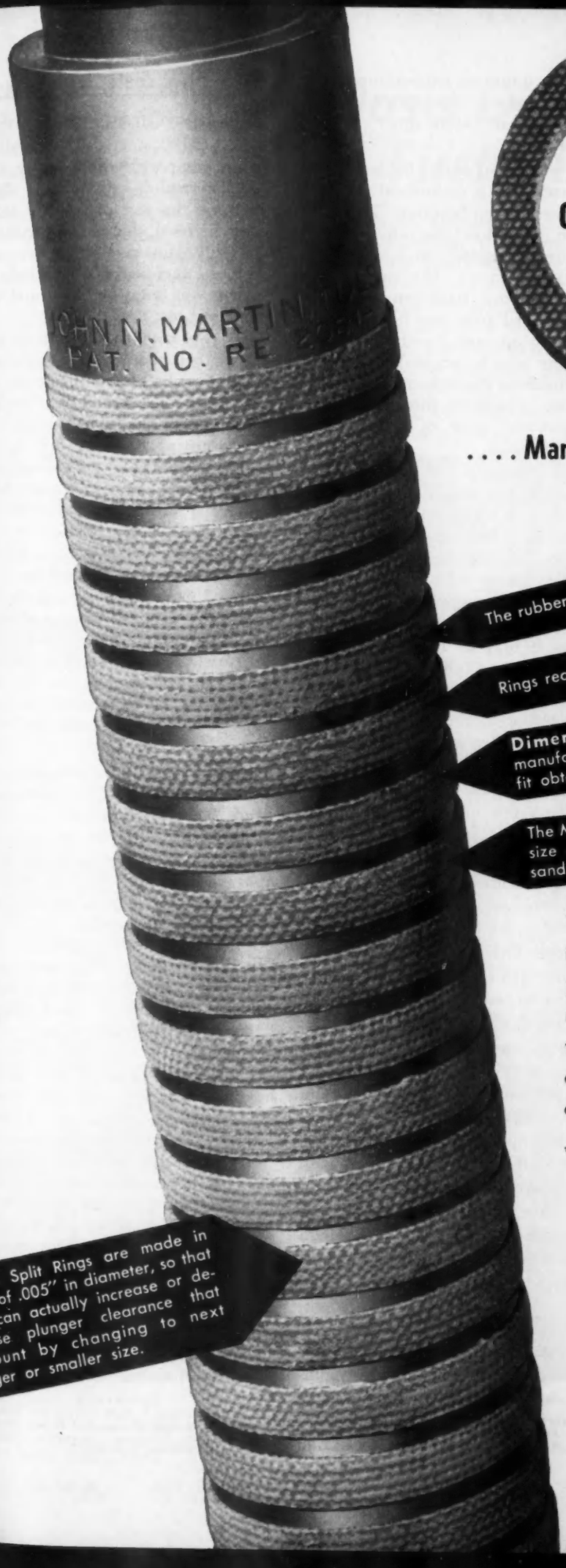
about 0.008 percent is actually dissolved in the iron. The remainder of the carbon (in the form of iron carbide) collects in little plates or balls separated from the iron crystals.

When steel undergoes transition from a body-centered to a face-centered lattice, the carbon atoms enter the more open crystal structure. Carbon atoms replace the iron atoms formerly at the center of the cubes and in effect "dissolve" in the steel. Up to 2 percent of carbon can be so tolerated in solution.

During cooling a partial reversal of these processes takes place. There is no change in the crystal size which depends upon the length of time the transition temperature has been exceeded. As the metal cools below 1,330° F., however, its structure shifts back to the body-centered lattice, and forces carbon out of "solution." This carbide again coalesces in platelets with the size and frequency of occurrence depending upon the rate of cooling. A multitude of tiny platelets is formed if the metal is cooled rapidly. If cooling takes place slowly, larger, thicker, less frequent platelets or lamellae are formed. These plates of carbide are called pearlite.

If the metal is cooled very rapidly carbon is trapped within the crystal lattice, resulting in a highly-strained condition. Such steels, known as martensitic, are very strong and brittle in comparison with normal ferritic steels in which carbon is present in the form of lamellated pearlite.

Applying this to tube-upsetting operations, it may be seen that when tube ends are heated above transition temperature the metal shifts in structure to the face-centered lattice. Old crystals break up and recrystallization takes place. These new crystals grow slowly while the metal is at the higher



GETTING CORRECT RING FIT IS EASY WITH

.... Martin Plungers and the Martin Method of Installation*

The rubber-and-duck rings swell **just so much** and no more.

Rings reach maximum size in the well within a few hours.

Dimensional Compensation during the manufacturing process assures the uniform working fit obtained with Martin Split Rings.

The Martin Ring Size Guide Table* assures proper ring size selection for various gravities, temperatures and sand and water content.

Martin Split Rings are made in steps of .005" in diameter, so that you can actually increase or decrease plunger clearance that amount by changing to next larger or smaller size.

The gaps between the Martin Rings cause fluid turbulence which slows down slippage past the Martin Plunger — just as a rough road slows down your driving speed. Actually, the Martin Plunger maintains pumping efficiency with a looser fit than is possible with a smooth surface plunger.

* See the complete Martin Catalog and instructions in the 1957 Composite Catalog.

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temperatures. When the temperature is lowered below the transition point, the crystals are "frozen" into their new size. The end of the tubing will be found to have the largest crystal size following upsetting operations. Crystal structure will be found increasingly smaller away from the tube end.

In the transition zone the shift from body-centered to face-centered lattice is found to be incomplete. Plates of pearlite from the original crystal structure of the metal have begun to break down. The iron carbide has separated into small chunks or spheres. This structure, known as spheroidized pearlite, is typical of incomplete transformation.

Farther along the tube normal crystal structure is found unchanged. The transition zone, characterized by the spheroidized pearlite, is the heat-affected zone while is highly susceptible to corrosion.

There are several theories concerning this corrosion susceptibility. Some corrosion engineers believe differences in electropotential between the spheroidized and normal metal areas cause the spheroidized areas to be anodic. Consequently they preferentially corrode when exposed to a corrosive liquid.

A second theory is that the lamellar nature of pearlite acts as a retardant to corrosion, each plate standing as a temporary barrier which slows down the progress of corrosive fluids dissolving away the metal. When these plates have been broken down into tiny balls (as in the case of spheroidized steel) corrosive liquids can easily penetrate and by-pass these spheres. Corrosion progresses at a much faster rate under these conditions.

Effects of ringworm corrosion can be seen in Figures 1 and 2. These photographs show two sections of tubing that have suffered attack, one internally, the other externally. The differences in structure are observable in the accompanying photomicrographs. The metal in Zone A has undergone recrystallization and exhibits well-developed pearlite. In Zone B, the transition zone, recrystallization was incomplete, and spheroidization of the original pearlite has occurred. Zone C represents metal that was not heated above the transition temperature, and which still retains the original crystal structure it had before upsetting operations.

Once the mechanism behind ringworm corrosion is understood preventive measures can be taken. The best solution is to subject the tubing (after upsetting operations) to a normalizing heat treatment. The entire tube is heated above transition temperature, removed from the furnace and allowed to air cool. In this manner, the entire tube is recrystallized, grain size is uniform throughout, the pearlite phase is uniform throughout and no "sensitive" zone of spheroidized pearlite remains.

Large furnaces are required for normalizing operations since most oil well tubing is furnished in 25-30 foot lengths. For this reason most mills make an additional charge for normalizing tubing following upsetting operations. Although normalizing may increase tubing costs from 8 to 10 percent, it may be more economical than the cost of failure and replacement.

Prevention of corrosion on tubing having heat-affected areas is possible; however, it is both difficult and expensive. Chemical inhibitors that retard the action of corrosive fluids on metal partially alleviate this condition. During conditions of extreme exposure (acidizing) special acid additives are available which provide more than 99 percent protection to the metal. Other inhibitors are available to retard corrosion resulting from exposure to corrosive well fluids. Such inhibitors are less efficient than the acid type, usually providing about 80 percent protection. The use of such inhibitors can greatly prolong the life of tubing in a well.

Such inhibitors are only a stop-gap measure. If ringworm corrosion is to be stopped, it must be prevented at the source. Operators who wish to avoid the trouble and replacement expenses resulting from ringworm corrosion (especially in wells where severe, corrosive sub-surface conditions are known to exist) should utilize tubing that has been fully normalized after upsetting. By eliminating heat-affected areas, tube life can be lengthened and well maintenance costs greatly reduced. **—The End**

V-belt drive costs

Continued from Page 109

2. The 6C-180 and 7C-180 standard belts are compared with 5C-180S and 6C-180S premium-quality belts. Tabulated are the cost per set of belts, the service level, the service per set of belts (still assuming 100 percent = 3 years), the number of sets of belts in ten years, the total belt cost and the annual belt cost.

First, we note that dropping one standard belt more than doubles the annual cost. Second, the cost per set of belts and the annual cost for 5C-180S premium-quality belts is approximately equal to those for 7C-180 standard belts. Last, the annual cost for 6C-180S premium-quality belts ($11.37) is less than half that for 7C-180 standard belts and less than one-fifth that for 6C-180 standard belts.

If the sheaves have become worn and need replacement or a change in speed requires a change in sheaves, the premium-quality belt drive allows less expensive sheaves. The sheave-cost saving is in addition to the belt-cost saving. For comparison, the motor sheave costs for each drive are given on the last line.

Summary. The true measure of a V-belt drive is not its horsepower rating. The true measure is the service the drive will give under conditions it encounters in operation. A study of the inter-relation of drive service with belt size and quality, load, speed and diameters, has resulted in a rational, quantitative, fatigue concept of belt service. This concept has been used to develop new drive design methods which allow the engineer to consider the economic aspects of V-belt drives.

Only a few uses of this method have been shown. Any time answers are needed to questions of V-belt drive service and cost, this new method is applicable. The conservative drive is the most economical. Each company's own rules on payout, maintenance cost and cost controls will govern the decision on drive economics. The method presented allows the engineer to compare numerically the economies of several courses of action and guides him in spending his money wisely for new installations and in saving maintenance costs.

REFERENCE

[1] E. G. Nelson. **V-Belt Drives for Pumping Units and V-Belt Drives for Heavy Machinery**, Denver, Colorado: Industrial Division, The Gates Rubber Company.

New Series of Wildcats Programed in Denmark

Danish American Prospecting Company (DAPCO) completed its fifth dry hole since last December 14 when Flyvbjerg 1 was abandoned at 5,580 feet on July 5, 1958. The rig was being moved northwest of the town of Horsens, where the next of the series of wildcats was to be spudded. DAPCO was rapidly evaluating Danish prospects, which are hampered by a predominantly shale section with little or no sandstone in depth.

Oasis Discovers Oil In First Libyan Test

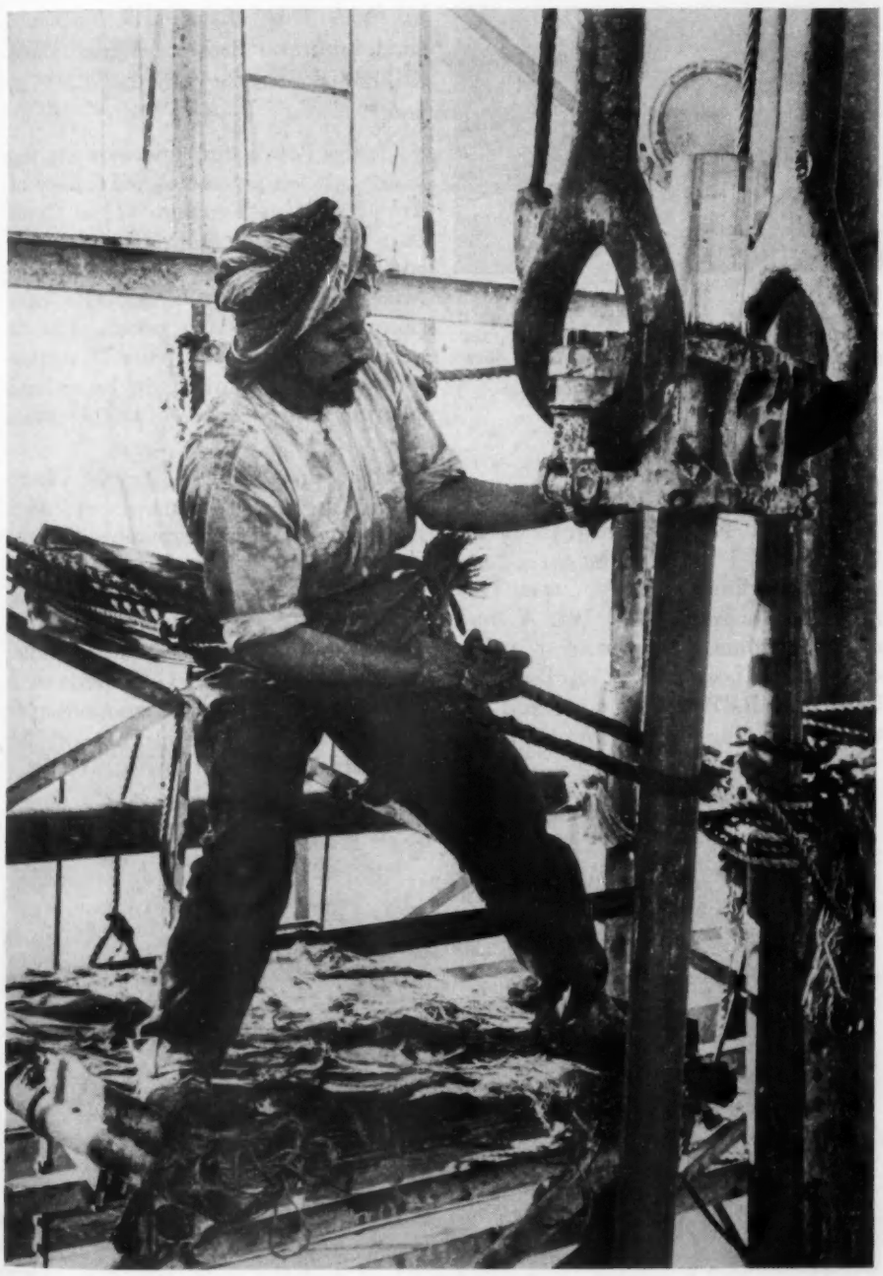
Oasis Oil Company of Libya has discovered oil in its first exploratory well in that North African country.

A drill stem test recovered 75 barrels of 30 degree gravity sweet oil in 2½ hours through a ¼-inch bottom hole choke. The interval tested was a 32-foot section between depths of 5,822 and 5,854 feet.

Oasis Oil, a wholly owned subsidiary of Ohio Oil Company, is operator of 62 million acres of concessions in Libya held in undivided one-third interests by Ohio Oil, Amerada Petroleum Corporation and Continental Oil Company.

The discovery well, the No. 1 Bahi, is in north central Libya, 75 miles south of the Gulf of Sirte. It is on a block of 1¼ million acres designated as Concession 32.

The Gelsenberg interests of Germany have agreed to acquire a 25 percent interest in Libyan activities of Mobil Oil of Canada (Libyan branch), subject to approval of the Libyan government. Mobil will operate the concessions and will have full control in the management of exploration, development and production.



Pipe Secure!

A Saudi Arabian employe of the Arabian American Oil Company secures a section of drilling pipe high up in the derrick at Manifa, Aramco's new oil discovery in the Persian Gulf.

INTERNATIONAL SECTION

Gulf Oil and Kerr-McGee Drill Test in Barbados

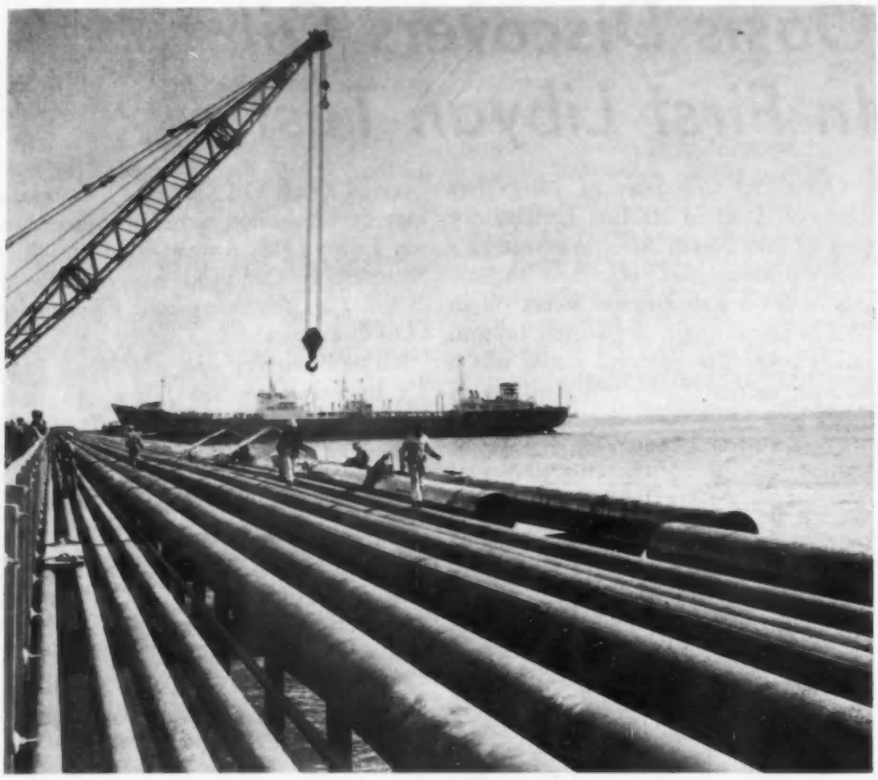
A projected 15,000 foot test on the island of Barbados was drilling in early July at 8,594 feet. The well is Gulf Morgan Lewis 1 of Barbados Gulf Oil Company (subsidiary of Gulf Oil Corporation) and Kerr-McGee Oil Industries, Inc.

Under agreement approved by the Barbados government, Kerr-McGee will earn a partial undivided interest in the prospecting license over the island held by Barbados Gulf, after reaching a certain stage of a joint project. Spudded March 17, 1958, the present test is in the Scotland district, near Belleplaine, on the Morgan Lewis plantation.

Pure Oil and Associates Start Paraguay Drilling

Drilling was started in early July on Paraguay's first oil exploration test in nine years. It is the wildcat of Pure Oil Company of Paraguay and associates in the remote, rugged Chaco territory, northern Paraguay.

The drilling follows eight months of intensive work since award of the



More Tankers Can Load

Installation of new pipe lines increases capacity for loading tankers at the Arabian American Oil Company's Ras Tanura terminal on the Persian Gulf coast of Saudi Arabia.

23,200 square mile concession. Over 2,400 tons of drilling and roadbuilding equipment and supplies were shipped in from the U. S. To reach the first drill site and a second projected location, operators are building 200 miles of graded road, mostly through dense forests of Quebracho trees.

Pure's associates are Williams Brothers Corporation and the Gulf, Tidewater and Sinclair oil companies.

In the late 1940s a U. S. company drilled five wells in other areas of Paraguay but failed to discover oil in commercial quantities.

Deep Wildcat Planned In Ivory Coast Area

Within a few months a deep wildcat will be started in the Ivory Coast of French West Africa by Plymouth Oil Company and Societe Africaine Des Petroles. Plymouth joined with the French company in the exploration program last January.

The exploration work has been well under way. It has included photogeological studies, marine geophysical work, land geophysical work and shallow core hole drilling.

Esso Fails to Find Pay In Deep Well in France

Esso REP Parentis 102 reached total depth of 14,281 feet by early June without finding the deep, lower Jurassic pay found in Well 101. A zone of reverse and/or overthrust faults was found near the bottom of the hole. Esso REP had no further plans to develop the deep Parentis reservoir.

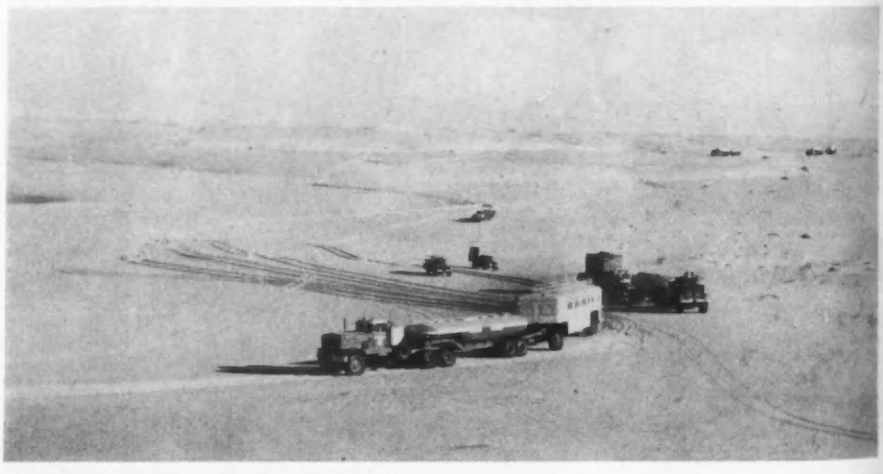
Chaco Petroleum Drilling Wildcat in South Bolivia

Wildcat drilling has been started by Chaco Petroleum, S. A., on the 900,000-acre lease acquired in southern Bolivia last year by four U. S. oil and gas companies.

Agua Salada No. 1 will be drilled to 12,000 feet to test the Tupambi sand, of Permian age. It is in the southwest part of the lease, a few miles north of Argentina's two major oil fields, Madrejones and Campo Duran. These Argentine fields, largest in South America outside Venezuela, are producing from the Tupambi sand. Loffland Bros. de Venezuela is drilling contractor on the Bolivian test.

Chaco Petroleum, operator on the lease, is a wholly-owned subsidiary of Tennessee Gas Transmission Company, of Houston. Other participants in the leases are the Bolivian subsidiaries of the Union Oil and Gas Corporation of Louisiana, which is headquartered in Houston; the Monsanto Chemical Company of St. Louis, and Murphy Corporation of El Dorado, Ark.

Meanwhile, Wilfred Tapper, Chaco Petroleum general manager, with headquarters in Cochabamba, Bolivia, announced that operations on the group's first well on the lease, Los Monos No. 5, will be resumed when the location again becomes accessible. Operations on this development well, which is located in a mountainous area, were suspended in February for the duration of the rainy season.



Exploration In Saudi Arabia

A seismograph party of the Arabian American Oil Company winds its way through the Rub' al-Khali, the "Empty Quarter" in southern Saudi Arabia, as it heads toward the next site for its exploration work.

Alberta's Stettler Field Extended by TGT Well

Tennessee Gas Transmission Company has brought in an indicated oil producer as an extension of the Stettler field in Alberta, Canada.

The well is the TGT Crown Stettler No. 1, drilled to a total depth of 5,312 feet. Production is indicated from the D-3 reef of the Devonian, after the well tested at approximately 150 barrels per day on a 16/64-inch choke.

The company's first well in the area, it extends production southwest of the Stettler field and indicates several additional proven locations on the company's acreage.

His Majesty, King Hussein of Jordan, at right, negotiates an oil development agreement with (left to right) Elmore D. Greaves, vice president and director, Zimeri-Jordanian Oil Co.; Harvey H. Hutchins, secretary-treasurer, director and associate general counsel; and Jorge Zimeri. The concession was originally granted to Zimeri and has been assigned by him to the Zimeri-Jordanian Oil Co.

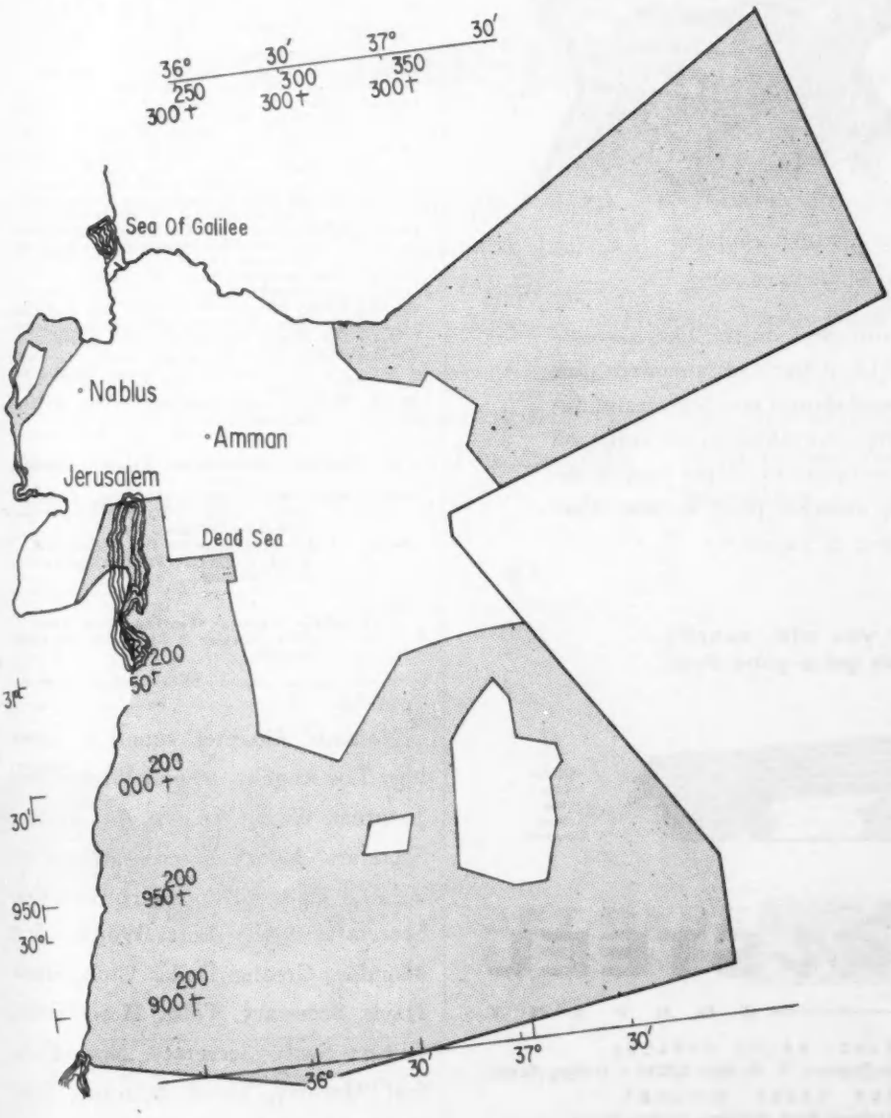
Zimeri-Jordanian Begins Jordan Exploration Work

The Zimeri-Jordanian Oil Company, Inc., has commenced exploration operations on its concession in the kingdom of Jordan. The company has offices in Amman and in Jackson, Miss.

Dr. Han C. A. Swolfs, chief geologist of the company, and Robert W. Tyson, chief of exploration, have been in Jordan recently, organizing surface geological parties, two of which are working in the Dead Sea Graben, Central and Northeastern Jordan.

The company obtained the right to explore all Jordan not included in the concession previously granted to Edwin W. Pauley.

This area open for exploration is shown on the accompanying map of the kingdom. By Sept. 13, 1958, the company must select one half of the area. The area so selected will consist of 8.3 million acres, or one third of all Jordan.



Map of the Kingdom of Jordan (left) shows the area (shaded) open for exploration by Zimeri-Jordanian Oil Company. On or before September 1 of this year, the company must select one half of this area.

Congrats and $25 to J. A. LONG, Rua Uruguaiana 118 - 9° andar Rio de Janeiro, Brazil

Joe Roughneck, heart of the oil and gas industry, likes the convenience and economy of having Lone Star's ultra-modern pipe mill right in the middle of his workshop. Lone Star maintains the largest mill stock of API casing and tubing in the entire oil country. Delivery can be made overnight to 75 per cent of the active areas. Lone Star's recently enlarged plant is, more than ever, Joe Roughneck's solid source of supply.

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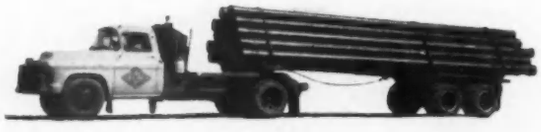

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WHO'S MEETING WHERE

SEPT. 1–13	Internation Conference on the Peaceful Uses of Atomic Engery, Geneva, Switzerland.
7–11	World Power Conference, Montreal, Quebec, Queen Elizabeth Hotel.
10–12	National Petroleum Association, 56th Annual Meeting, Atlantic City, N. J., Traymore Hotel.
15–19	Instrument Society of America, 13th Annual Instrument-Automation Conference and Exhibit, Philadelphia, Penn.
18–20	Rocky Mountain Association of Geologists, Annual Field Trip, Northwestern Colorado, Glenwood Springs, Colorado.
21–24	AIME, Conference on Petroleum, Denver, Cosmopolitan Hotel.
25–26	Mid-Continent Oil & Gas Assn., La.-Ark. Division, Annual Meeting, New Orleans, Roosevelt Hotel.
OCT. 1– 3	AAODC, 18th Annual Meeting, Dallas, Adolphus and Baker Hotels.
5– 8	AIME, Society of Petroleum Engineers, Fall Meeting, Houston
7–8	Texas Mid-Continent Oil & Gas Assn., 39th Annual Meeting, Dallas, Statler-Hilton Hotel.
10–12	Tri-State Oil Show, The Roberts Municipal Stadium, Evansville, Ind.
12–18	OIL Progress Week.
13–15	AGA Annual Convention, Atlantic City, Site Unreported.
13–16	Society of Exploration Geophysicists, 28th Annual International Meeting, San Antonio, Gunter Hotel.
15–16	South Dakota Independent Oil Men's Assn., Convention, Rapid City, S. D., Sheraton-Johnson Hotel.
15–17	Second Energy Resources Conference, Denver, Brown Palace Hotel.
16–17	AIME, Southern California Petroleum Section Fall Meeting, Los Angeles, Biltmore Hotel.
16–19	1958 Permian Basin Oil Show, Odessa, Texas.
23–24	Rocky Mountain Oil and Gas Association, Annual Fall Meeting, Town House Motel, Omaha, Neb.
23–25	AIME, Mid-American Minerals Conference, Chase, Plaza Hotels, St. Louis.
27–28	IPAA Annual Meeting, Dallas, Statler-Hilton.
NOV. 6–7	AAPG Pacific section, Annual Meeting, Los Angeles.
10–13	API 38th Annual Meeting, Chicago, Conrad Hilton, Palmer House and Congress Hotels.
21–22	"Legal Problems in the Tidelands" Study Program, Tulane University, New Orleans.
DEC. 5	ASME, Annual Meeting, New York City, Statler & Sheraton-McAlpin Hotels.

Nomads' Chapter monthly meeting: Los Angeles, second Wednesday, Jonathan Club, Wallace A. Sawdon, Secretary. Houston, second Monday, Ye Old College Inn, Harry E. Estes, Secretary. Dallas-Fort Worth, first Monday, Greater Dallas Club, Hank Davis, Secretary. Tulsa, Hotel Tulsa, Gilbert Swift, Secretary. New York, first Monday, Hotel Biltmore, Jesse E. Hickman, Secretary.

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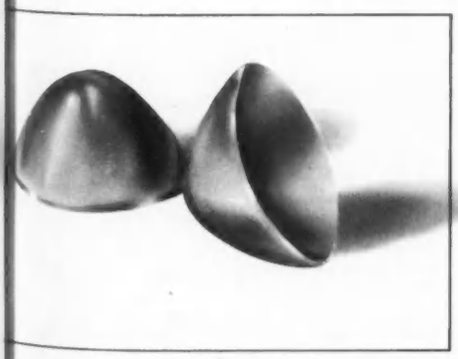

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DRILLING HINTS

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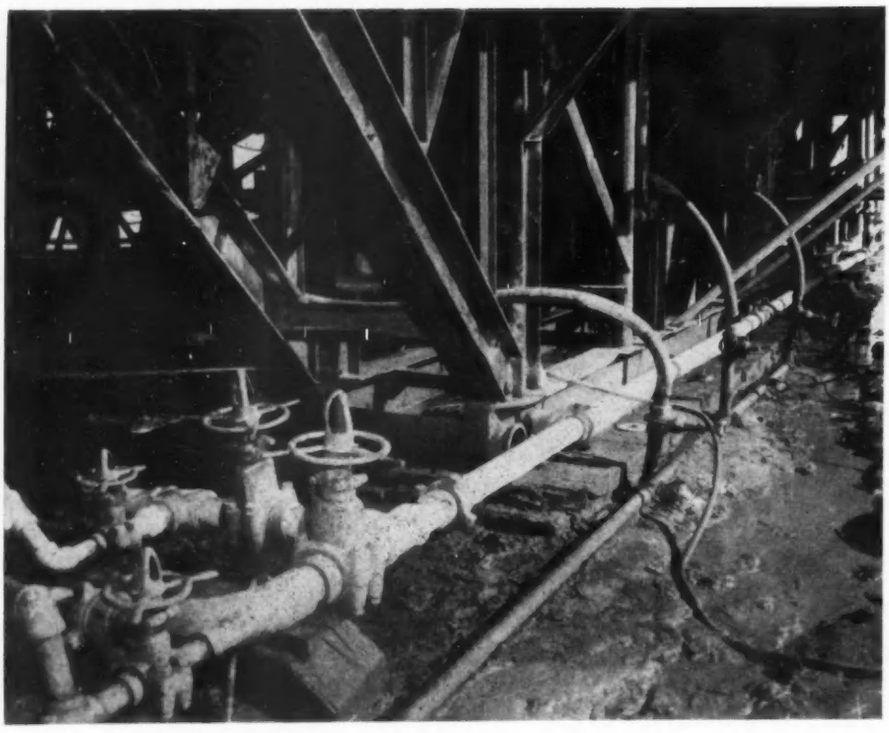


Hook Mud Line to Side of Rig for Speed

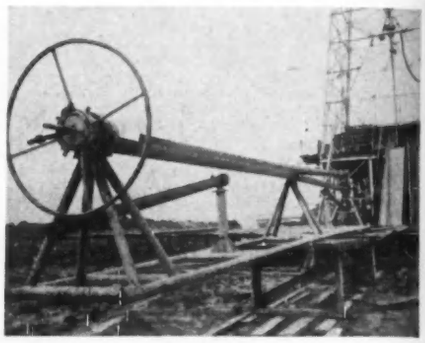
A permanent hookup with the mud line fastened to the side of the subbase will make it easy to connect up the mud pump when the rig is moved. The clamps are made by welding a nipple to the side of a quick coupling and welding it fast to the side of the subbase. The mud line is then laid inside of the unions and clamped to the I-beams.

A hammer union is installed at the inlet side of the mud line so that the valve cluster from the mud pumps can be easily installed. When it is time to rig down, the cluster is broken off in one piece at the quick acting union, and the mud line moves with the substructure. When it is time to rig up, it is a simple matter to block up the valve cluster and reconnect the mud line.

Laying Down Drill Pipe Speeded With This Cradle

This rig for laying down drill pipe replaces the old pipe buggies and wire rope. It consists of a cradle made of 6-inch pipe split through the middle and a large wheel mounted on the outer end. The upper piece is laid up on the derrick floor and the drill pipe turned loose and allowed to slide into the piece that revolves.

As soon as it is in place, a roughneck turns the wheel on the end, and the pipe rolls off onto the rack. The



braces shown beneath the rack are used for skids and swung out on the pipe rack after the device is spotted at the side of the rack.

Since the joints of pipe come down with a thunder from the rig floor, it is necessary to have bumper springs on each end of the cradle so that the threads will be protected. The pipe strikes the back loaded plate, bounces against the front and then settles down to where it can be easily rolled off onto the rack. The contractor found that this device saves extra men when he is laying down drill pipe.

How-To-Do-It Ideas Earn Money, too!

WORLD OIL editors want how-to-do-it ideas, so your favorite short cut or invention could put money in your pocket! Write down the substance of your latest ideas and send them in with a picture or drawing of the installation . . . if accepted, $10 for each idea will be yours. Send those money-making ideas today to Hints Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas.

Guard Provides Overhead Protection for Rig-Runner

This picture illustrates an easily constructed, removable, overhead guard which is used to protect the driller from objects falling from the derrick. It also serves as an excellent foul weather shield.

The unit consists of a simple frame of angle iron covered by galvanized sheeting. Measuring 10 feet by 20 feet, the guard is hinged to the housing over the draw works to facilitate easy removal. It is held in the position shown by small lines attached to the derrick.

When a trip is made, the catline is used to raise the shield up and out of the way. It is then secured in a vertical position thus providing the driller with maximum visibility while running or pulling pipe.

The guard is easily and cheaply constructed and provides an effective means of overhead protection for the rig-runner.

Unitized Walkway Serves Dual Purpose in Winter

Unitized walkways are coming into wide usage in many parts of this country and Canada. Besides providing safe access from tool houses, boilers etc. they are sometimes put to other uses.

Illustrated above is a compact walkway used in the northern portion of the country and Canada. Especially adapted for usage in cold weather climates, the walk is easily constructed of angle iron and ¼-inch steel plate. The plate has numerous advantages over units constructed with expanded metal. Besides serving as a walk, the unit above is being used to insulate steam and water lines between the boilers and the rig. The insulation provided can be extremely valuable during periods of severe cold weather.

Pick-up eyes are provided for ease of handling by trucks during rigging up and down operations. Handles are also installed so the walks may be moved by hand to repair lines, if necessary. A coat of non-skid paint can also be applied to the walk surface to insure good footing.

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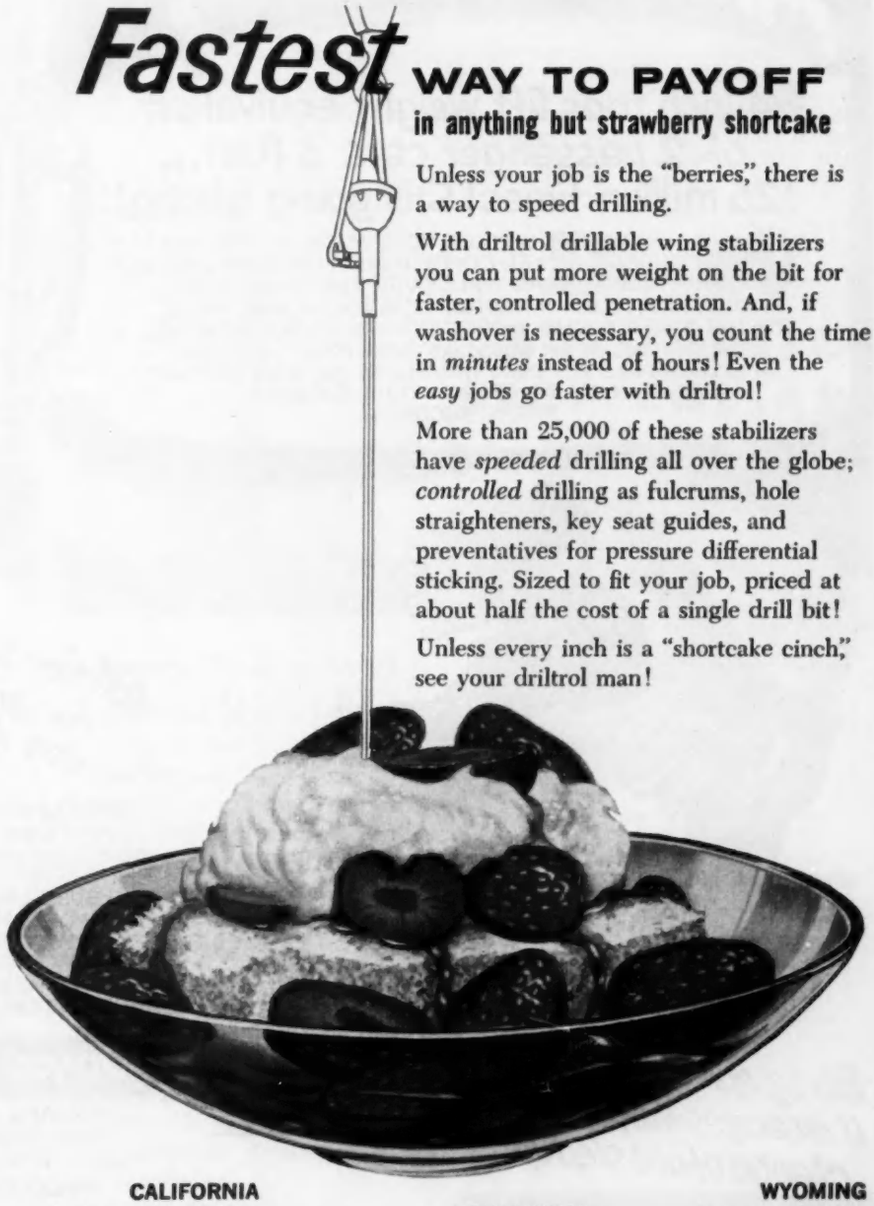

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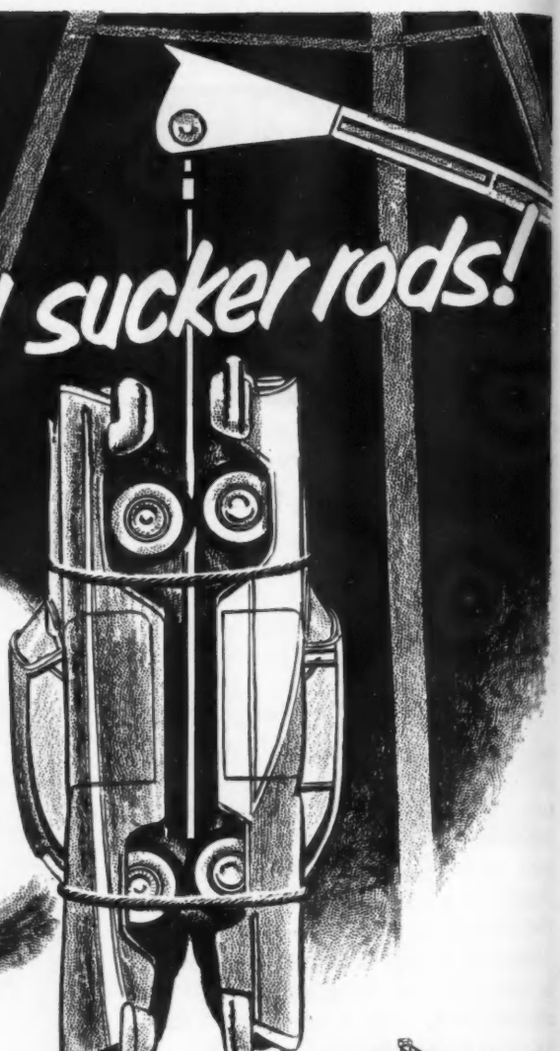
FIELD FACTS

Amazing "K" Monel sucker rods!



3/4-inch rods lift weight equivalent of 2 passenger cars 3 feet... 126 million times! Still going strong!

3/4-INCH DIAMETER SUCKER RODS MADE OF "K" MONEL* AGE-HARDENABLE NICKEL-COPPER ALLOY WERE INSTALLED IN SOUR WEST TEXAS WELL OVER TEN YEARS AGO. EXCEPT FOR BRIEF INTERRUPTION TO CHANGE WELL TUBING, THIS STRONG, CORROSION-RESISTING "K" MONEL STRING HAS BEEN WORKING EVER SINCE—LIFTING AND DROPPING ITS OWN WEIGHT PLUS THAT OF THE COLUMN OF OIL (8690 POUNDS) EVERY THREE SECONDS!

Barograph so sensitive it measures the pressure change of one step up.

HIGHLY SENSITIVE INSTRUMENT—USED FOR CORRECTING GEOLOGISTS' ALTIMETERS—CHARTS AIR PRESSURE VARIATIONS AS SMALL AS 0.0003 PSI...THE EQUIVALENT OF AN 8-INCH STEP UP A FLIGHT OF STAIRS. HEART OF THE BAROGRAPH IS A MONEL NICKEL-COPPER ALLOY ACTUATOR. MONEL ALLOY WAS PICKED BECAUSE IT RESISTS CORROSION EVEN IN DAMP, SWAMPY COUNTRY, WHICH WOULD ALTER CRITICAL DIMENSIONS AND AFFECT ACCURACY.

65-foot "leggings" for giant's sea legs...

GIANT LEGS OF HUGE 10-STORY HIGH S-55 OFFSHORE DRILLING RIG—LARGEST SEAGOING RIG EVER LAUNCHED IN NEW ORLEANS—ARE PROTECTED IN CRITICAL SPLASH ZONE BY THIN 0.031-INCH MONEL* NICKEL-COPPER ALLOY SHEATHS. 65 FEET FROM TOP TO BOTTOM! MONEL SHEATHING HAS PROVEN ITSELF THE MOST PRACTICAL WAY TO CONTROL SPLASH CORROSION.

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Parts or Odds and Ends Bin Allows Good Housekeeping

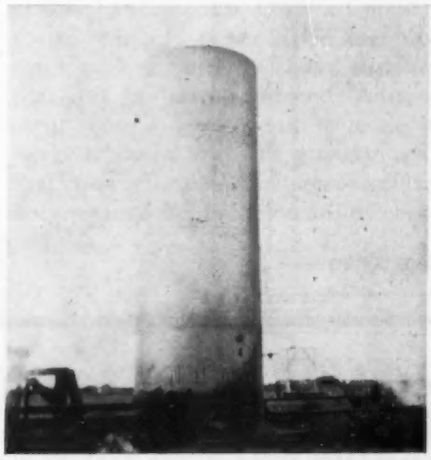
To maintain good housekeeping on his rig, a Gulf Coast contractor has built a bin for odds and ends parts. He has mounted the bin in the substructure next to the pipe rack where the crew can easily place parts or odds and ends for later use. This aids not only in good housekeeping, but also in safety.

The bin can be constructed as desired. The illustrated bin is constructed from pieces of sheet metal welded together to form a rectangular box.

Adjust Pump Belt Tension With Drill Pipe and Studs

A simple method of maintaining tight pump belts and proper pump alignment can be built by using a piece of 4½-inch drill pipe and two long studs and nuts from a blow-out preventer. The drill pipe is welded or bolted to the substructure to form a solid immovable base, and the long blow-out preventer studs are welded to the end rolls of the pump skid.

Holes of sufficient diameter to allow the long blow-out preventer bolts to be pushed through are bunted through the drill pipe with a cutting torch. The nuts are first screwed on to the long bolts, and then as the pump skid is placed in position, the long bolts go through the holes in the 4½-inch drill pipe base. The nuts act as a stop. To adjust the tension, the nuts on the long blow-out preventer studs are backed off. This forces the skid base of the pump away from the drill pipe base and increases the tension on the belt. This enables the operator to maintain a more even tension and alignment, thereby lengthening belt life on the pumps.



Store Excess Drilling Mud In Cylindrical Steel Tanks

A vertical, cylindrical steel tank was utilized by one Gulf Coast drilling contractor for storage of excess high weight drilling mud. In many instances where costly drilling mud is converted over, the excess mud is wasted or contaminated by storage in open reserve pits.

Storage in a cylindrical, closed steel container minimized this problem and made it a simple matter to maintain the mud in the original state, eliminating any contamination by rain or surface water. It is difficult to prevent contamination if storage is in an open reserve pit.

Since the steel tank is a tall, cylindrical type, the mud level is always above that in the mud pits. If it is desirable to use mud from the tank storage, the 4-inch gate valve in the outlet connection, near the bottom of the tank, will allow accessibility by gravity flow, quickly and easily.

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WHY? Because field tests made on "average" oil field welding for mounting scratchers and centralizers have shown a great variation in weld quality, and damage from undercutting, hard spots, and electrolytic corrosion. Now there is no longer any need to depend entirely on welding for scratcher and centralizer installations with possible damage to valuable equipment. You can completely eliminate welding on casing, and at the same time get an economical scratcher and centralizer installation that will not interfere with normal casing running practice . . .

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These How-To-Do-It Ideas Can Save You Money

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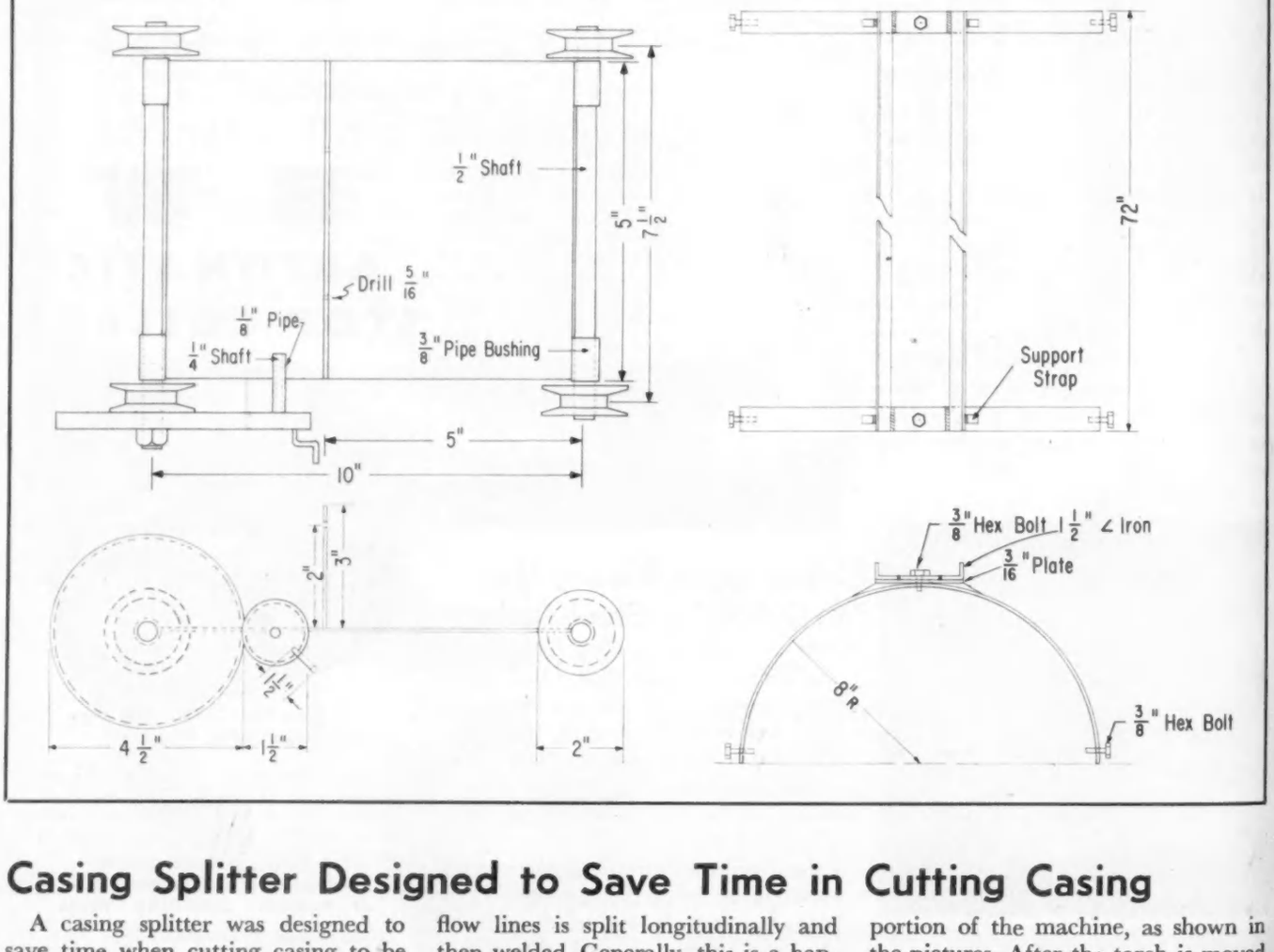


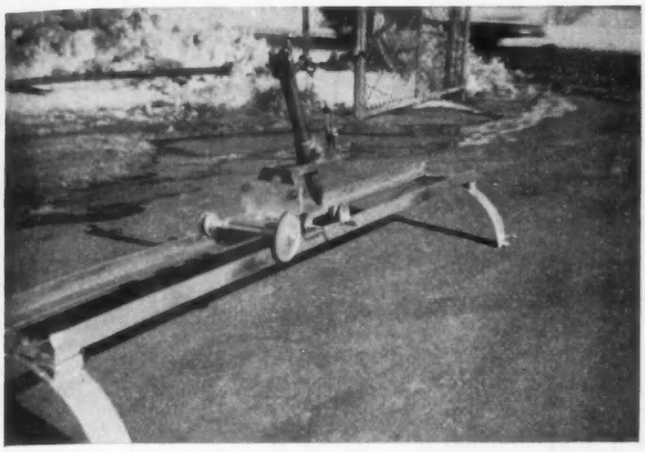
Casing Splitter Designed to Save Time in Cutting Casing

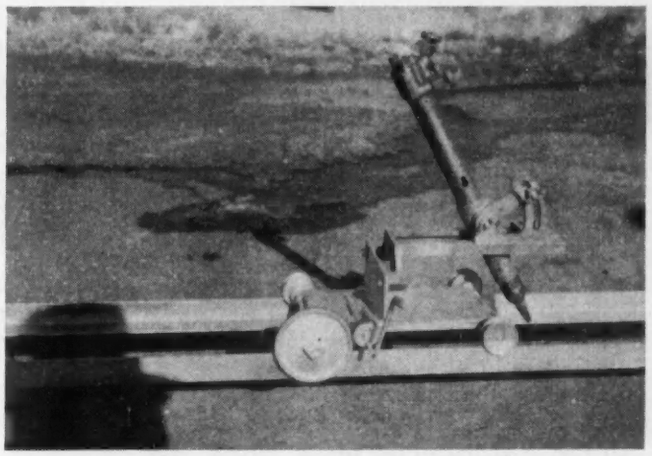
A casing splitter was designed to save time when cutting casing to be installed as a protector over pipe line and flow line crossings under roads, railroads etc. Most every pipe line or flow line crossing under a traveled right-of-way is protected by casing that is cut and welded back together to provide an open housing. The lines can be easily removed, if necessary, with this system.

Normally, installation of the protector pipe is handled by a welder. The casing to be placed around the flow lines is split longitudinally and then welded. Generally, this is a haphazard operation; inasmuch as it is difficult to make a straight cut along the pipe, resulting, therefore, in additional time required to weld the seams.

The operation has been simplified by one company by use of a casing splitter where the welder needs no help to cut a joint of pipe, up to 50 feet in length. The machine is simply placed over the pipe, and the cutting torch head is fastened to the dolly portion of the machine, as shown in the pictures. After the torch is moved along by the crank mechanism, a smooth straight cut is made on the pipe. It is then very simple to weld the split pipe sections together for a neat, faster job. The casing splitter, shown in the pictures, is made from 1½-inch angle iron mounted on two semi-circle end sections of metal that are placed on top of the casing to be cut.

To build the casing splitter as illustrated by the detailed drawing, two





sections of 1½-inch angle iron, 72-inches in length, are welded to a 3/16-inch plate, which is welded to two end sections of 16-inch diameter semi-circular metal. For precision adjustment, 3/8-inch hexagonal bolts are placed in three positions on the semi-circular end sections. This portion of the casing splitter is placed over the pipe to be cut. After the entire unit is placed over the pipe, the cutting torch head is fastened to the crank mechanism, and the machine can be moved along by the welder.

The cutting torch head is fastened to the "dolly," as shown in the pictures, with a butterfly clamp support that can be hand tightened. Adjustment for the desired cutting angle is easily achieved with the angular arm that moves inside the semi-circular slot provided for precision adjustment.

Handle Cylinders Safely With Loading Platform

When loading or unloading cylinders of oxygen, a simple platform built from angle iron reduces the hazards of handing high pressure cylinders. Two short pieces of chain, welded to the center piece on each side, can be securely fastened to hold

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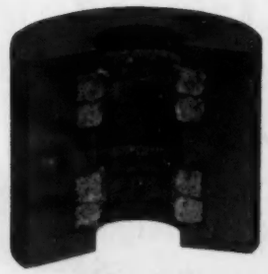

For **HERCULES** Stuffing Boxes

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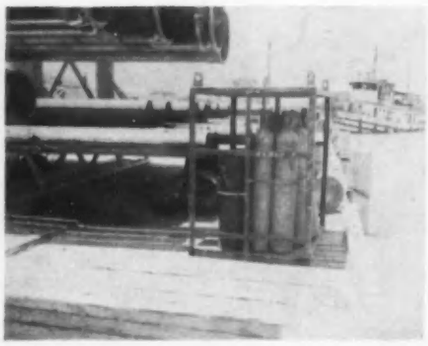


a number of cylinders in place and assure fixed position when in transfer. A cable attached to the lifting "eyes" shown, can be used for a swing to load and unload the framework from a truck, loading platform, dock or barge.

This device is very useful where a number of cylinders are required on a welding job. Handling of individual cylinders is eliminated.

Bury Used Drum to Serve As Oil, Water Receptacle

The buried drum shown in the photograph plays an important role on this lease. It serves as a sump to catch oil leaking from a triplex pump and as a receptacle for oil and water from a gas locked circulating pump.

A 1-inch line is run from the triplex pump spacer block to the drum. The one-fourth to one-half barrel of oil per day that leaks by the pump plungers and liners is collected. The oil is then picked up by the circulating pump and returned to stock.

The circulating pump shown often gas locks when first started. Instead of bleeding oil and water through the pump and onto the ground, it is drained into the drum through ½-inch copper tubing which leads from the discharge side of the pump. A 1-inch line with check valve and strainer is connected from the drum to the suction side of the pump. Liquid originally bled into the drum may be picked up after the pump is operating satisfactorily.

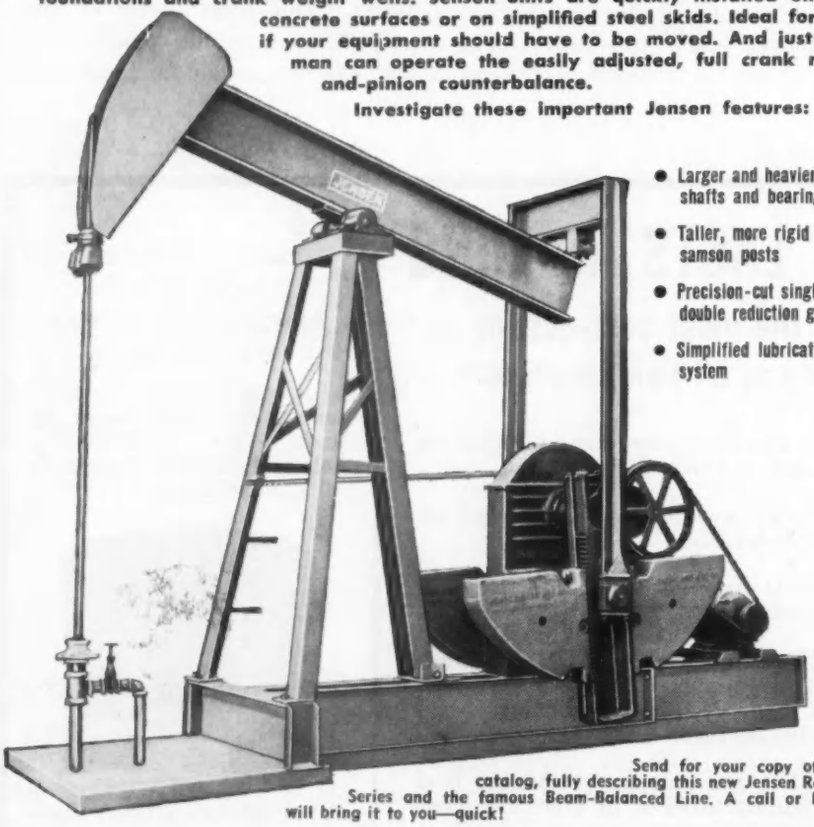
The installation is an excellent example of good housekeeping, safety, and economy.

The New JENSEN Rotary Balanced JACK offers:

COMPLETE FLOOR CLEARANCE FULL CRANK BALANCE

Your next well will be easier and less costly if you equip with the all-new Jensen Rotary Balanced Pumping Jack. You eliminate the need for expensive foundations and crank weight wells. Jensen units are quickly installed on flat concrete surfaces or on simplified steel skids. Ideal for use if your equipment should have to be moved. And just one man can operate the easily adjusted, full crank rack-and-pinion counterbalance.

Investigate these important Jensen features:



- Larger and heavier main shafts and bearings
- Taller, more rigid samson posts
- Precision-cut single and double reduction gears
- Simplified lubrication system

Send for your copy of our catalog, fully describing this new Jensen Rotary Series and the famous Beam-Balanced Line. A call or letter will bring it to you—quick!

STOCKED BY YOUR LOCAL SUPPLY STORE

Made by JENSEN BROS. MFG. CO., INC., P. O. Box 477-D, Coffeyville, Kansas

***Export Office:* 250 Park Avenue, New York 17, N. Y.**

JENSEN JACKS

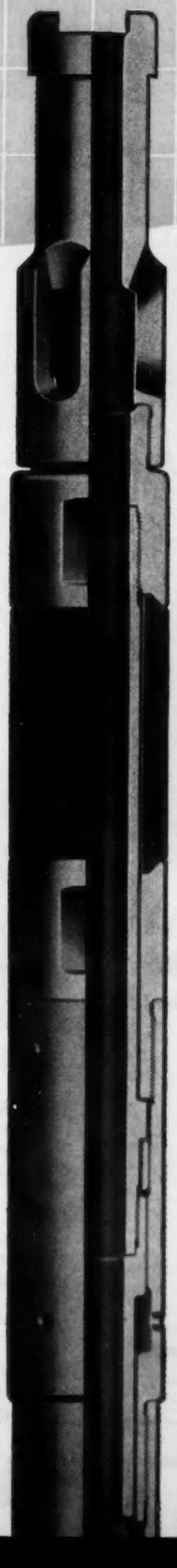
How-To-Do-It Ideas Earn Money, too!

WORLD OIL editors want how-to-do-it ideas, so your favorite short cut or invention could put money in your pocket! Write down the substance of your latest ideas and send them in with a picture or drawing of the installation . . . if accepted, $10 for each idea will be yours. Send those money-making ideas today to Hints Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas.

engineered well tested and approved

oilmaster

Automatic TOP SEAL



The OILMASTER Automatic Top Seal is designed for use with a stationary barrel bottom anchored pump to stabilize the top of the pump and to prevent sand or other foreign material from settling in the annulus between the pump and the tubing string.

No special actuation is required to set or release the Automatic Top Seal. When the pump is seated, the weight of the rods will expand the rubber and press the brass friction ring into the restricted throat of the housing, holding the rubber in the expanded position. The rubber will remain set until the pump is removed from the well, at which time the plunger contacts the bumper nut, moving it upward and causing it to press the friction ring out of the restricted throat. This permits the rubber to return to its non-expanded position.

Ports are provided in the housing to equalize fluid pressure between the pump and the tubing string, giving hydrostatic support to the outside of the barrel while the pump is operating, and permitting fluid to drain past the top seal when the pump is unseated. Automatic Top Seals are available for use on stationary barrel bottom anchor pumps in 2″, 2½″, and 3″ tubing.

Ask your OILMASTER representative to demonstrate the advantages of the Automatic Top Seal.

Write Box 64, Los Nietos, California, for technical literature.

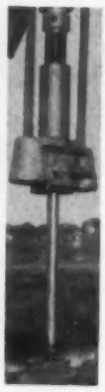
- PREVENTS SAND FROM SETTLING AROUND PUMP
- DEPENDABLE, LONG-LASTING SEAL
- POSITIVE HOLDING, FRICTION RING DESIGN
- INCREASES SERVICE LIFE OF PUMP

FLUID PACKED PUMP CO.

Main Office and Plant, Los Nietos, Calif.

Distributed by the National Supply Co., Pittsburgh, Pa.
Export: The National Supply Co., Export Division, 600 Fifth Ave., New York
Co-Distributors: Union Supply Store, Beacon Supply Co., Industrial Supply Co.

Pumper's Bumper



MURRAY POLISH ROD ADJUSTER

OPENS SUB-SURFACE VALVES

CORRECTS GAS, SAND LOCK

At last a practical, safe, efficient and economical answer to solve the pumper's major problem.

LENGTHENS STRING

CUTS ACCIDENTS, LOST DOWN-TIME

Quickly and accurately takes all guess work out of bumping sub-surface valves open and back into production. No more lost shut-down time, costly accidents to personnel or equipment. Pays for itself quickly with increased production formerly lost in hit-and-miss adjustments of polish rod clamps.

Two Sizes Available

Model #2875 . . . $39.95*
Fits 1⅛" & 1¼" Polish Rod
Closed Length 8¾"
Adjustment 6"

Model #375 . . . . $87.50*
Fits 1⅜" & 1¼" Polish Rod
Closed Length 12"
Adjustment 7"

*Slightly higher in Canada

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CALL YOUR NEAREST STORE
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Colorado Rep.

DISTRIBUTORSHIPS OPEN . . . INQUIRIES INVITED

What's Happening among SERVICE and SUPPLY MEN

William S. Morris

Perry T. Egbert

ALCO Products, Inc., has announced the election of **Perry T. Egbert** as chairman and **William S. Morris** as president. Egbert had been president of the company and Morris executive vice president. Egbert and Morris had held their former offices since 1952.

Oil Metering and Processing Equipment Corp. has announced the appointment of **J. D. Kimmel** as sales and design engineer. Prior to joining Oil Metering, Kimmel worked as an engineer for Phillips Petroleum Company and Union Oil of California. He was most recently employed by Parkersburg Rig and Reel Company as a sales engineer for oil production equipment.

David G. Willis was promoted from publications manager to advertising manager of **Magnet Cove Barium Corporation.** He succeeds **Ben A. Weil,** who has left the company. In his new position, Willis will also retain his former responsibilities as publications manager. His experience includes three years as a member of the editorial staff of PETROLEUM REFINER, a Gulf Publishing Company publication.

David G. Willis

John R. Mueller was appointed service manager of the Witte Engine Works of the Oil Well Supply Division, **United States Steel Corporation.**

Carl D. Hanson has been appointed unions sales representative for **Clayton Mark & Company** in the Gulf Coast states. Hanson will represent Clayton Mark in southeastern Texas, Arkansas, Alabama, Louisiana and Mississippi.

George D. Doremus has joined the staff of the **George E. Failing Company** in the capacity of works manager. For the past 16 years Doremus has been production planning manager for Le Tourneau-Westinghouse.

H. C. Thomason, formerly **Schlumberger Well Surveying Corporation** district manager at Medicine Lodge, Mont., has been named senior sales engineer at Great Bend, Kan.

William Newashe, Jr., branch manager, formerly in charge of operations in **McCullough Tool Company's** Big Piney/Rock Springs, Wyoming area, with headquarters at Big Piney, has been transferred to McCullough's Cortez, Colo., branch office.

D. H. Thornbury was elected president of **Mid-Continent Supply Co.** Ken W. Davis was named chairman of the board of the Fort Worth, Texas, organization. Thornbury began work with Mid-Continent Supply in 1929 in Houston as district manager. A year later, he was made vice president and later moved to Fort Worth. He had served as executive vice president and a director of the company since 1947.

D. H. Thornbury

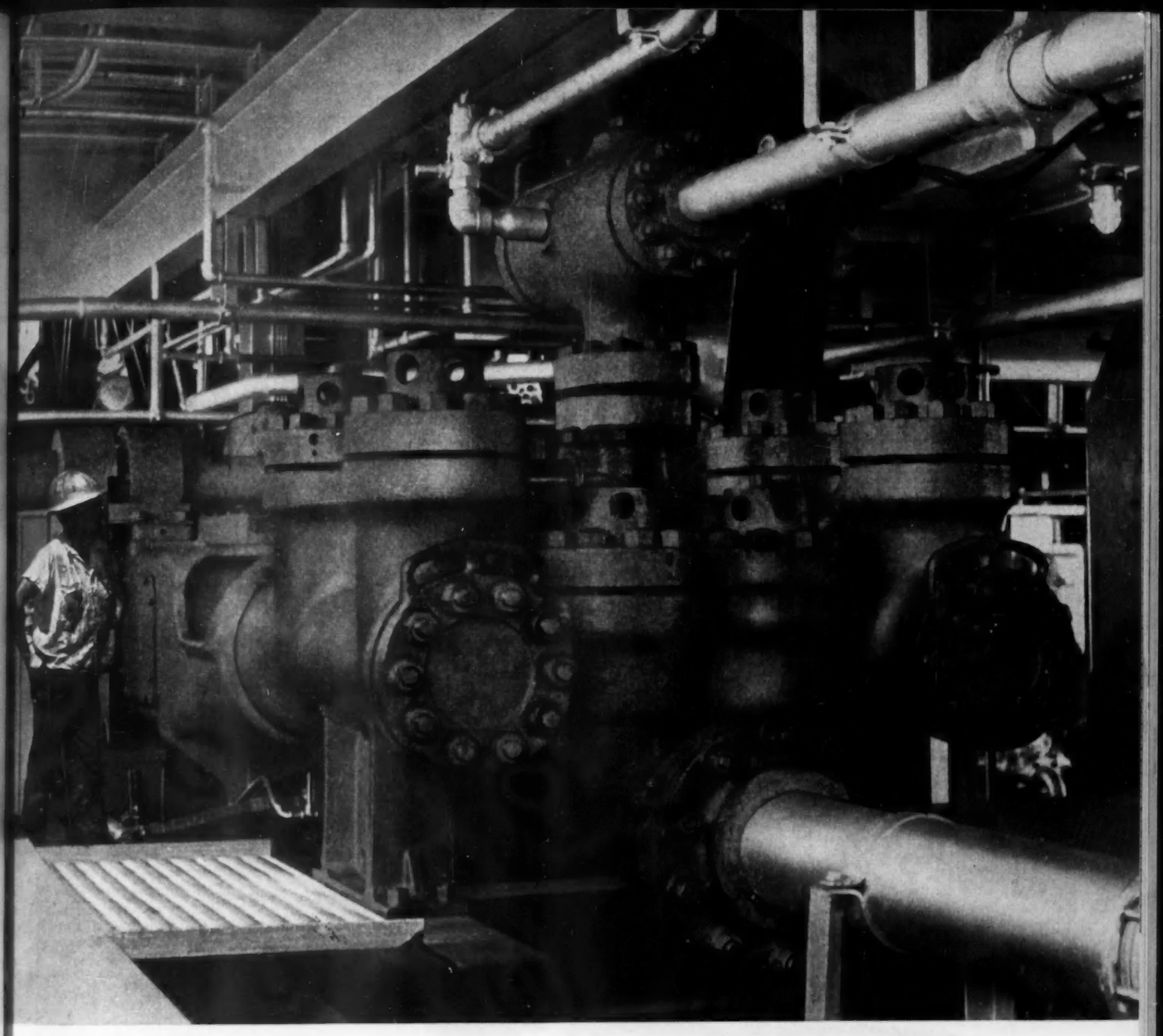
Robert G. Pearson has been named sales representative to manage operations for **driltrol corporation** stabilizers in the Mid Continent and Rocky Mountain areas. Pearson was formerly associated with Geolograph, serving for eight years as the firm's sales and service manager in Oklahoma and the Four Corners area.

H. B. Lee was named vice president in charge of operations, and **Clifford F. Moore** was named assistant treasurer of **Welex, Inc.**

Clinton F. Kucera was appointed manager of the New York district office of **Allis-Chalmers Industries Group.** In his new post, Kucera succeeds **N. W. Landis,** recently named manager of Allis-Chalmers Northeast region.

Blaz A. Lucas, Jr., has been appointed manager of sales for the Ingersoll Products division of **Borg-Warner Corp.** Lucas succeeds **Robert A. Anderson** who is retiring as vice president—sales after more than a quarter of a century of service.

C. J. (Neil) McBride has been appointed sales manager for the East Texas-Northern



Six Bethlehem Slush Pumps
for high-pressure drilling

Keeping the pressures high—and thus assuring powerful jets at the bottom of the hole—is a basic function of every Bethlehem slush pump. In this detail, as in others, Bethlehem pumps have won respect wherever heavy-duty pumping service is required. All six sizes can be counted on to keep those pressures high.

These pumps are built to give years of steady service under tough field conditions. They're durable, smooth in operation. Maintenance is minimized with the straightforward design and precise construction of a Bethlehem slush pump. Features include flood lubrication of the power end; roll-forged heat-treated gear; replaceable crosshead slides; high-capacity roller bearings; all-steel fluid end.

Call our nearest office or store for engineering data.

A size for every drilling job

Model	Bore & Stroke, In.	Nominal Input Hp	Max. Pressure with Min. Standard Liners
H-25	7¼ x 12	250	1383 lb
G-35	8 x 14	350	1485 lb
G-45	8 x 16	450	1691 lb
G-65	8 x 16	650	2460 lb
G-85	8 x 18	850	3066 lb
B-1640	8 x 16	1500*	4570 lb

*Higher hp permissible up to 2000 at 90 s.p.m.

BETHLEHEM SUPPLY COMPANY
General Offices: 21 E. Second St., Tulsa, Okla.
West Coast Headquarters: Los Angeles, Calif.
Canadian Distributor: Bethlehem Supply Company of Canada, Ltd. Calgary, Alberta, Canada
Export Office: Bethlehem Supply Company (Export Division) 25 Broadway, New York, N. Y.

BETHLEHEM SUPPLY

Louisiana area for **Tubular Lining Corporation.** McBride will have his area headquarters in Shreveport.

Walter J. Buehring

Charles O. Zagst

Charles O. Zagst was appointed vice president of sales for **Waukesha Sales & Service, Inc.,** and **Walter J. Buehring** as vice president in charge of service parts. Zagst has been associated with Waukesha Sales & Service since 1949. Buehring has been with Waukesha Sales for 12 years.

William H. Hiatt, district engineer—machinery and equipment sales and services of **United States Steel Corporation's** Oil Well Supply Division, was transferred from New Orleans to Jackson, Miss.

Tretolite Company division of Petrolite Corporation has made recent transfers and additions to its staff of field service engineers. **Wayne L. Brown,** Tretolite field service engineer at El Dorado, Kan., has been transferred to Anaco, Venezuela. He has been replaced at El Dorado by **Troy Driver,** formerly Tretolite representative at Lindsay, Okla. **LaVern L. Trompke** has been named field service engineer at Kimball, Nebr.; **Norman J. Ruder** has been assigned to Plainville, Kan.; **James H. Turner** to New Iberia, La.; and **Leigh L. Slade** to Odessa, Texas.

S. R. Bowen Company announces the opening of a Houston office in the Bank of the Southwest Building. They plan to serve customers in the Gulf Coast and Mid-Continent areas. **Al Spardis,** who has served the company in a number of capacities at Santa Fe Springs headquarters, has been appointed manager of the Houston office.

Al Spardis

Welex, Inc., has named **R. C. Starrett** as manager of the Salem, Ill., district. Starrett has been associated with oil field service work for 19 years—7 years of this time he has spent with Welex.

Walter Lee Henry, who has had extensive experience in all phases of production management, has been elected vice president, manufacturing, of the **Rolo Manufacturing Company.** Henry was associated with the Continental Can Company for 21 years before joining Rolo. Assignments with Continental included that of superintendent of production at the Chicago plant. Previous to that he was assistant plant manager at Continental's Houston plant. Henry has been with Rolo for 2½ years and was plant manager until his recent promotion.

Walter Lee Henry

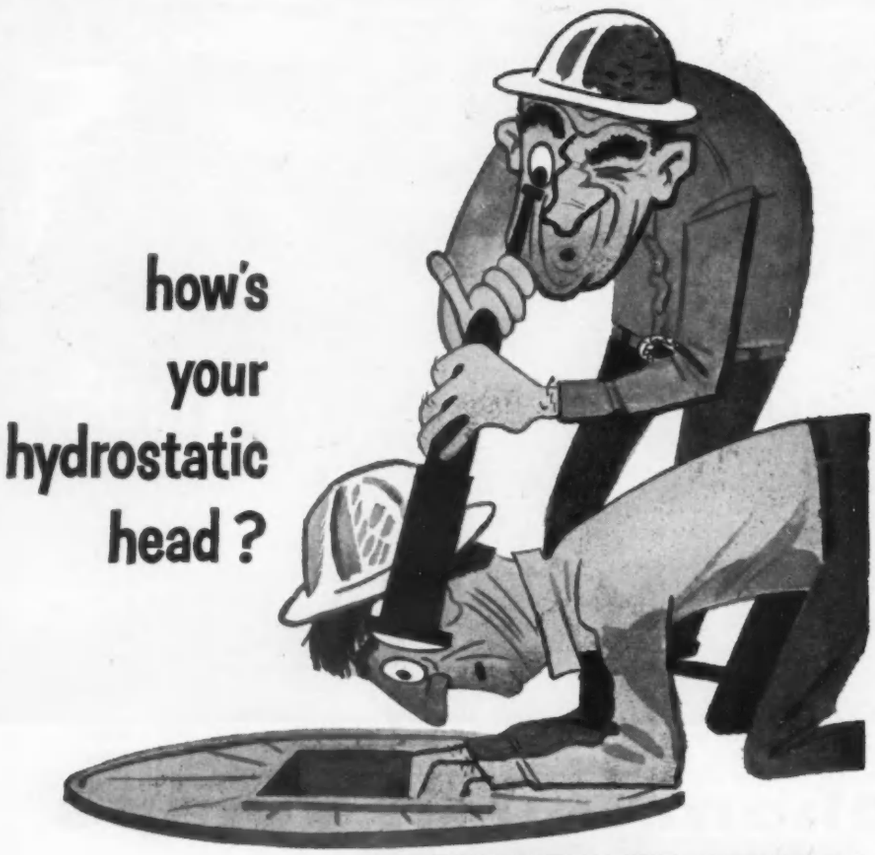
Winslow A. Randle has been named manager of the Houston office of the **Shafer Valve Company**—manufacturer of valve operators and controls.

H. C. Smith Oil Tool Company has announced the appointment of **L. G. Cook** as sales and service representative for the company in Venezuela. He will headquarter in Maracaibo.

Frank DeLarzelere has been appointed sales manager of **Enardo Manufacturing Company.**

Robert D. Butler has been appointed to assistant to sales manager—plug valves for **W-K-M,** division of **ACF Industries, Incorporated.**

McCullough Tool Company Eastern division sales department recently announced the following changes. Those recently promoted to the position of sales representative for McCullough are **Billy F. Davis,** Natchez, Miss.; **J. C. Warren,** Magnolia, Ark.; **James E. Hampton,** Pampa, Texas; and **D. B. Berry,** Shreveport, La. Sales representatives recently transferred include: **A. D. Wilson,** formerly at Odessa,



SEE WHAT'S HAPPENING DOWN THE HOLE WITH **Pit-O-Graf**

(Records mud pit level)

From the Pit-O-Graf chart you can calculate effectively any loss in hydrostatic head due to gas or salt water incursion. The continuous mud pit level chart warns of blowouts or threatened blowouts and loss of circulation.

WARREN AUTOMATIC TOOL CO.

Manufacturers of Mud-O-Graf and Rig Runner.

3915 Tharp St. Houston CApitol 4-2511

Lake Charles, La. HEmlock 6-2265

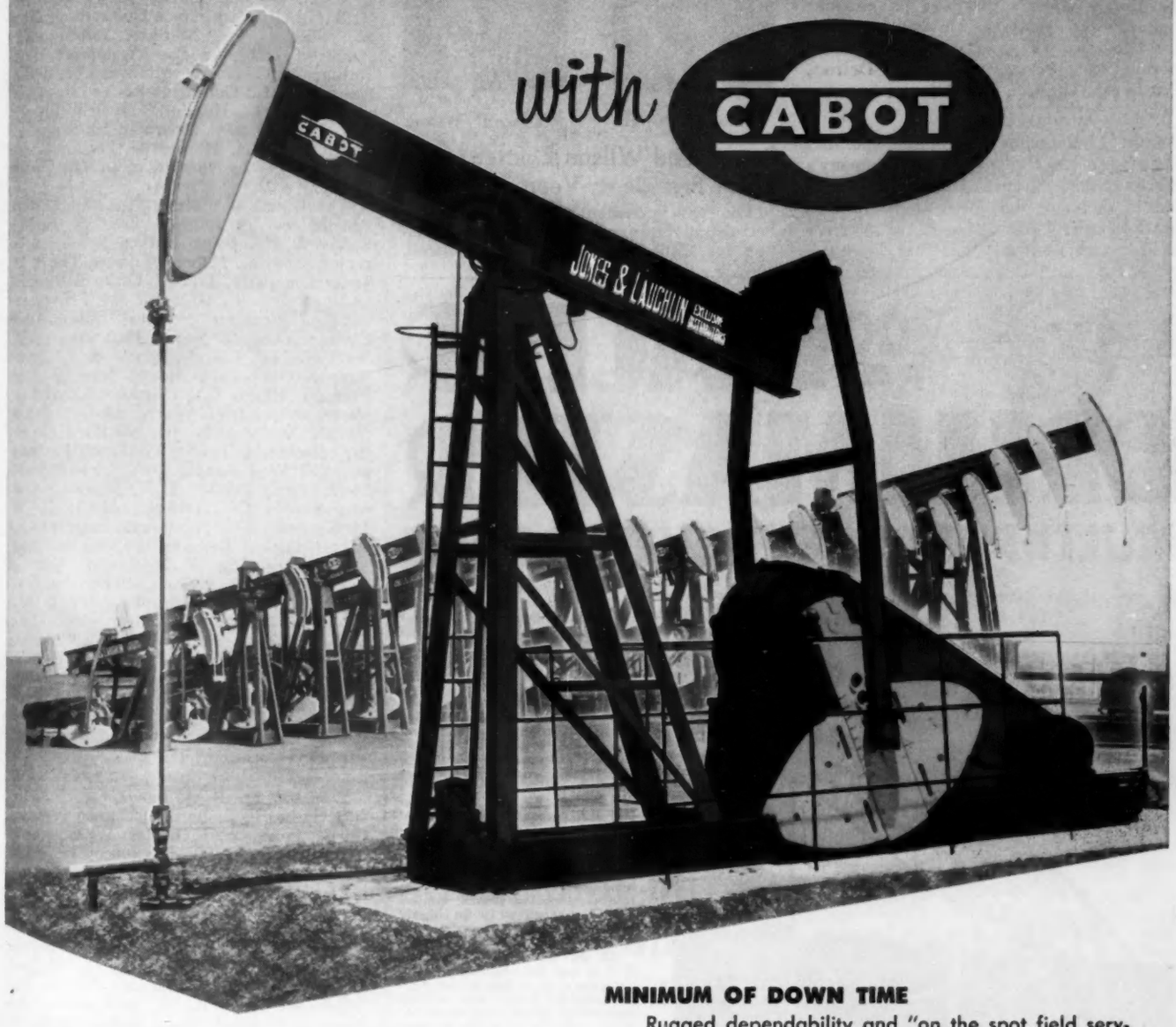
New Iberia, La. EMerson 9-9862

Harvey, La. FOrest 6-1441

DEPENDABLE RUGGED PUMPING

3,000 TO 32,000 POUNDS MAXIMUM POLISHED ROD LOAD

with CABOT



ADJUSTABLE CRANK BALANCED

Cabot adjustable crank pumping units are available in sizes from 7,000 to 32,000 pounds maximum polished rod load. Adjustments are simple. One man can make them from the ground. No heavy lifting. No complicated tools needed. All that's required is to loosen two bolts, move weights to desired position and tighten bolts. Single-piece inner weights easily added.

BEAM BALANCED

Cabot beam balanced pumping units are available in sizes from 3,000 to 11,000 pounds maximum polished rod load. Full beam counterweighting furnished. Weights can be easily installed any place along the beam without moving other weights. Safety rails provided. 15% crank counter weighting optional. Easily installed with two bolts.

MINIMUM OF DOWN TIME

Rugged dependability and "on the spot field service" provide a pumping unit assuring you of less down time. Cabot's 24-hour parts and maintenance shops at Odessa, Houston, Alice, Kilgore, Pampa, Compton, Great Bend, Lindsay, Seminole, Tulsa, Casper, Farmington, and Edmonton.

OIL FIELD PUMPING EQUIPMENT
CABOT SHOPS, INC.
PAMPA, TEXAS
FRANKS DIVISION OF CABOT

There's a quality Cabot pumping unit to meet your needs. Call your J&L Supply Man.

Texas, who was transferred to McCullough's Victoria, Texas, branch office; and **Bobby L. Martin**, formerly at Cortez, Colo., who was transferred to Odessa, replacing Wilson.

Clark Bros. Company, one of the Dresser Industries, has tapped **Robert J. Spears** for the newly created post of assistant general sales manager. He will supervise the company's Eastern district offices of Boston, New York, Philadelphia, Detroit, Pittsburgh, Chicago and Atlanta.

Adrain Fitzsimmons has been appointed manager of **McCullough Tool Company's** Sterling, Colo., branch. **Harmon P. Burns**, former manager, has been transferred to McCullough's Farmington, N. M., branch in the same position.

William J. Powell

Wallace D. Wilson

Powell and Wilson Elected PESA President, Veep

The new president of the 1958-1959 Petroleum Equipment Suppliers Association for 1958-1959 is William J. Powell, Continental-Emsco Company, Dallas. Wallace D. Wilson of Wilson Supply Co., Houston, is vice president.

Other officers are H. R. Safford, Jr., executive secretary, Houston; Wharton Weems, treasurer, Houston; and Leroy Jeffers, assistant treasurer.

The executive committee is composed of F. E. Bernsen, Lucey Products Corp., Tulsa, chairman Finance Committee; Donald Mackie, Jr., Bradford Supply Co., Bradford, chairman Eastern district; W. L. Butler, W. C. Norris, Manfacturer, Tulsa, chairman Mid-Continent-Rocky Mountain district; F. L. Hereford, Murray-Brooks, Inc., Lake Charles, chairman Southwestern district; and H. H. Peters, Technical Oil Tool Corp., Los Angeles, chairman Pacific district.

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In the Mid-Continent and Rocky Mountain district, Davis D. Bovaird, Bovaird Supply Company, Tulsa, is director at large.

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The Southwestern district has three directors at large on its board of directors. They are Fred M. Mayer, Continental-Emsco, Dallas; M. E. Montrose, Hughes Tool Company, Houston; and Wallace D. Wilson, Wilson Supply Co., Houston.

Other directors are H. H. Allen, Cameron Iron Works, Houston; Howard B. Book, Reed Roller Bit Co., Houston; Ken W. Davis, Mid-Continent Supply Co., Fort Worth; Ott Hammer, Dresser Operations, Dallas; Frank L. Hereford, Murray-Brooks, Inc., Lake Charles, La.; Elliott Johnson, Schlumberger Well Surveying Corp., Houston; W. H. Larkin, Larkin Packer Co., Waxahachie, Texas; L. A. Little, Lufkin Foundry & Machine Co., Lufkin, Texas; John J. Neale, Lane Wells Co., Houston; George O'Leary, Houston Oil Field Material Co., Houston; Ray O. Shaffer, Welex Jet Services, Fort Worth;

BRITISH H-E MADE 300 P.A. TRACTOR

DRILLMASTER

MULTI-PURPOSE · HIGHLY MOBILE

The Hands-England Drillmaster 300 P.A. Rotary Drill is now available mounted on a Fordson Major Tractor and is illustrated on left.

This design provides great manoeuvrability and is intended primarily to enable the well known H-E Drillmaster 300 P.A. Rotary Drill to be used for Quarry and Open Cast blast or shot holes.

Although the H-E Drillmaster 300 P.A. mounted on a diesel engined tractor, is ideal for Quarry and Open Cast operations, it is equally applicable to some difficult "off the road" locations, such as may be encountered during seismic exploration particularly in highly cultivated areas.

An air compressor giving 99 C F M can be mounted directly onto the drill subframe and driven from the tractor engine. This compressor gives an up-hole annular velocity of 3,000 ft./min. when using flush jointed drill pipe and holes of the following sizes:

1⅝" o/d. Drill Pipe	2⅞" dia. hole
1.29/32" " "	3⅛" " "
2⅜" " " "	3⅜" " "
2⅞" " " "	3¾" " "

Larger holes or holes drilled with mud circulation can of course be drilled, but the equipment for these operations must be mounted on a separate trailer or tractor.

The H-E Tractor Drillmaster will be found to cover the majority of drilling requirements of the Quarry and Open Cast operator, the Geologist, the Mineralogist, and the Geophysicist.

Write for illustrated folders giving full details and specifications of this equipment.

HANDS-ENGLAND OILFIELD EQUIPMENT LTD

MANUFACTURERS OF GEOPHYSICAL SUPPLIES

LETCHWORTH HERTS ENGLAND TEL: 600 CABLES: OIL LETCHWORTH ENGLAND

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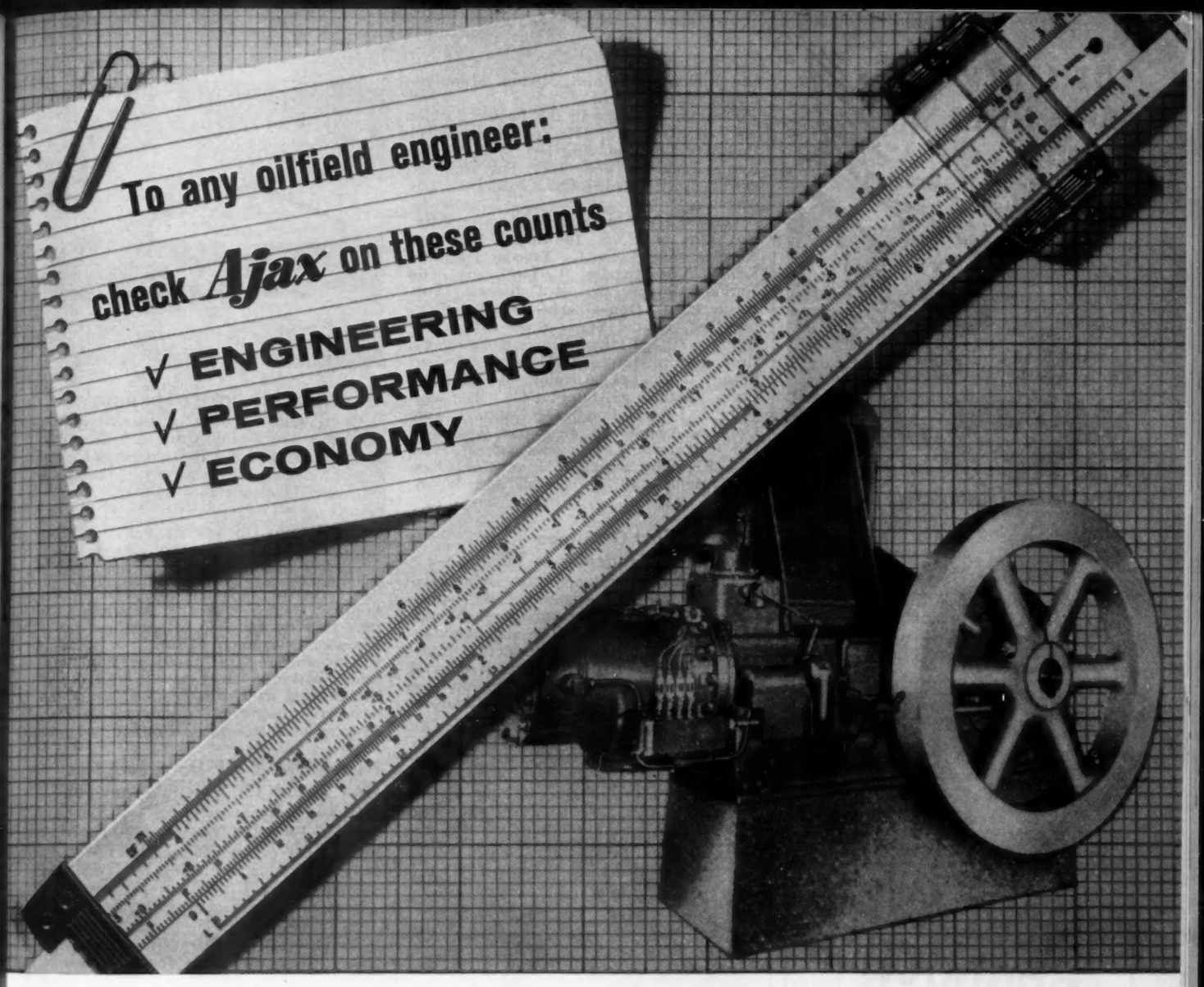

. . . and discover that the soundest gas engine concept is the simplest and most efficient in practical results

The 2-cycle gas engine, an integral part of oil production since the very beginning, is as *new as today* when it bears the AJAX nameplate. In the past decade the Ajax program of continuous, creative engineering development has brought the 2-cycle engine fully into its own—delivering greatly increased horsepower for the same bulk—economy far outrunning any other type of prime mover—continuous, unsupervised operation for months on end if need be—and *maintenance as low as Ajax life is long.*

• For the rugged jobs, the 2-cycle engine gets the call. For top quality performance, call on Ajax! Your Supply Man will be glad to oblige.

GAS ENGINES AJAX SINCE 1877

Ajax IRON WORKS

Builders of GAS AND OIL ENGINES · PRESSURE PUMPS

CORRY, PENNSYLVANIA

Oil Field Distributors: THE NATIONAL SUPPLY CO., PITTSBURGH, PA. · R. B. MOORE SUPPLY CO., BOLIVAR, N. Y. · BETHLEHEM SUPPLY CO., TULSA, OKLAHOMA

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BRITISH H-E MADE

300 P.A. TRACTOR DRILLMASTER

MULTI-PURPOSE · HIGHLY MOBILE

The Hands-England Drillmaster 300 P.A. Rotary Drill is now available mounted on a Fordson Major Tractor and is illustrated on left.

This design provides great manoeuvrability and is intended primarily to enable the well known H-E Drillmaster 300 P.A. Rotary Drill to be used for Quarry and Open Cast blast or shot holes.

Although the H-E Drillmaster 300 P.A. mounted on a diesel engined tractor, is ideal for Quarry and Open Cast operations, it is equally applicable to some difficult "off the road" locations, such as may be encountered during seismic exploration particularly in highly cultivated areas.

An air compressor giving 99 C F M can be mounted directly onto the drill subframe and driven from the tractor engine. This compressor gives an up-hole annular velocity of 3,000 ft./min. when using flush jointed drill pipe and holes of the following sizes:

1⅝" o/d. Drill Pipe	2⅞" dia. hole	
1.29/32" "	" " 3⅛"	" "
2⅜" "	" " 3⅜"	" "
2⅞" "	" " 3¾"	" "

Larger holes or holes drilled with mud circulation can of course be drilled, but the equipment for these operations must be mounted on a separate trailer or tractor.

The H-E Tractor Drillmaster will be found to cover the majority of drilling requirements of the Quarry and Open Cast operator, the Geologist, the Mineralogist, and the Geophysicist.

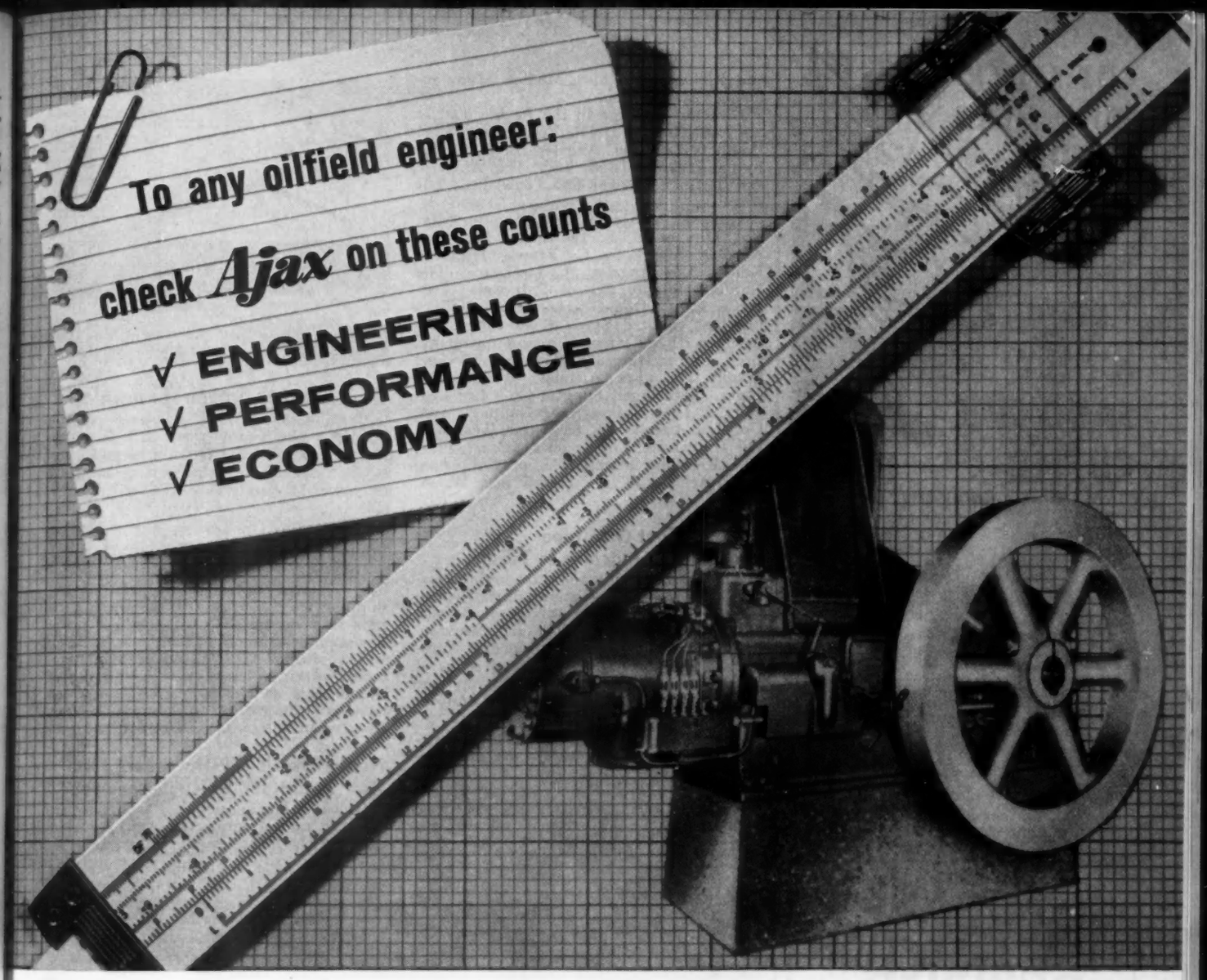
Write for illustrated folders giving full details and specifications of this equipment.

HANDS-ENGLAND OILFIELD EQUIPMENT LTD

MANUFACTURERS OF GEOPHYSICAL SUPPLIES

LETCHWORTH HERTS ENGLAND TEL: 600 CABLES: OIL LETCHWORTH ENGLAND

Exclusive licensees in Western Germany: August Goettker Flachbohrungen, 20a Wathlingen Kreis Celle, West Germany



. . . and discover that the soundest gas engine concept is the simplest and most efficient in practical results

The 2-cycle gas engine, an integral part of oil production since the very beginning, is as *new as today* when it bears the AJAX nameplate. In the past decade the Ajax program of continuous, creative engineering development has brought the 2-cycle engine fully into its own—delivering greatly increased horsepower for the same bulk—economy far outrunning any other type of prime mover—continuous, unsupervised operation for months on end if need be—and *maintenance as low as Ajax life is long.*

• For the rugged jobs, the 2-cycle engine gets the call. For top quality performance, call on Ajax! Your Supply Man will be glad to oblige.

GAS ENGINES AJAX SINCE 1877

Ajax IRON WORKS

Builders of GAS AND OIL ENGINES · PRESSURE PUMPS

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Oil Field Distributors: THE NATIONAL SUPPLY CO., PITTSBURGH, PA. • R. B. MOORE SUPPLY CO., BOLIVAR, N. Y. • BETHLEHEM SUPPLY CO., TULSA, OKLAHOMA

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KINLEY SAND LINE CUTTER

M. M. Kinley Company, Licensees

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Hudson-Eads, Inc. .....OR 2-5331
BAY CITY, TEXAS
J. P. Graham.....CI 5-4526
BEAUMONT, TEXAS
Assoc. Eng. & Eqpt., Inc....TE 5-7046, ZF 8-2029
CASPER, WYOMING
C. A. White.....3-5204
GLENDIVE, MONTANA
C. A. White.....EM 5-3833
HOBBS, NEW MEXICO
Horne Well Service Co.....3-5396
HOUSTON, TEXAS
Assoc. Eng. & Eqpt., Inc.....CA 5-1103
KILGORE, TEXAS
Davis-Kemp Tool Co., Inc.....5541
LAFAYETTE, LOUISIANA
Assoc. Eng. & Eqpt., Inc.....CE 5-6770
LIBERAL, KANSAS
Rainbo Service .....Main 4-3598
LINDSAY, OKLAHOMA
Rainbo Service Co.....530
MIDLAND, TEXAS
Lucceus Service & Eqpt. Co.....MU 2-1631
NEW ORLEANS, LOUISIANA
Assoc. Eng. & Eqpt., Inc.....VE 5-4983
OKLAHOMA CITY, OKLAHOMA
Rainbo Service Co.....ME 4-2131, ME 4-0105
WHITTIER, CALIFORNIA
Kline Wire Line Co.....OX 6-2731
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CLEAN OUT CHOKING SAND

Excessive sand and sediment holds back your oil. For fast, easy clean out with fewer round trips and less down-time, use world famous Miller Sand Pumps.

SAND PUMP SIZES
O.D.—2½, 3, 3½, 4¼, 5, 5½, 7 in.
Lengths—20, 25, 30 ft.

Composite Catalog, Page 3419

Write for descriptive price list

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Miller Sand Pump Co.
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Oklahoma City 9, Okla

EXPORT OFFICES
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NEW YORK CITY 20, N. Y.

and Richard E. White, Mission Manufacturing Co., Houston.

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Directors are James Beré, Axelson Mfg. Co., Div. of U. S. Industries, Inc., Los Angeles; Markley C. Brown, Hillman-Kelley, Los Angeles; J. L. Evans, The National Supply Co. of California, Torrance, Calif.; Don Grubbs, Oil Well Supply Div., United States Steel Corp., Los Angeles; H. J. Hagn, Chiksan Company, Brea, Calif.; Harold E. Howard, Howard Supply Co., Los Angeles; Wendell M. Jones, Bethlehem Supply Co., Los Angeles; I. J. McCullough, McCullough Tool Co., Los Angeles; H. H. Peters, Technical Oil Tool Corp., Los Angeles; John J. Pike, The Republic Supply Co. of California, Los Angeles; W. T. Powell and W. A. Wilson.

SSC Has First Omnitape Transcribing Machine in Tulsa

The first Omnitape transcribing machine is now in operation at the world-wide headquarters of Seismograph Service Corporation in Tulsa. The intricate machine, built by Hale Instruments, translates information from various systems of seismic magnetic recording into any one of a selection of systems for uniform analysis.

According to Nelson K. Moody, manager of SSC's replay center, the new system will take seismic data recorded in one of the principal systems now in use, and record them in a uniform system so data can be co-ordinated in oil exploration work.

Continental-Emsco Expands

Continental-Emsco Company recently opened a new supply store in Venice, La. Located to serve the Delta area and many of the offshore rigs, the store is managed by James D. Hunter.

Shipside Rig-Up for Export Speeds S & R Tool Shipment

Drilling equipment for foreign service now receives faster rig-up, testing and shipping from S & R Tool & Supply Co.'s new shipside rig-up yard at the Port of Beaumont, Beaumont, Texas.

The new, S & R rig-up yard in Beaumont, within a city's block's distance of ship-loading tackle, is serviced by 40-ton locomotive cranes for speedy rig-up, teardown, packaging and loading for shipment.

Newly-Formed CP-Harrisburg, Inc Now Agent for Chicago-Pneumatic

Chicago Pneumatic Tool Company announced the formation of a marketing and distribution arrangement with Ken W.

AMC Completes Offshore Oil Drilling Barge

American Marine Corporation of New Orleans announced this week the completion and acceptance of another giant offshore oil drilling barge, The Seadrill No. 2. The 180-foot drilling barge is the second built by AMC for Sea Drilling Corporation, and it's now preparing to join The Seadrill No. 3 in offshore oil operations. It's designed to operate in water up to 30 feet deep and has a 60-foot by 74-foot helicopter deck.

Davis of Fort Worth, Texas, president of Harrisburg Sales & Service, Inc. The marketing and distribution of Chicago Pneumatic oil field products will be handled by a new Texas corporation formed by Davis and called CP-Harrisburg, Inc. Guy J. Coffey, president of Chicago Pneumatic, stated that the new company is not a subsidiary of Chicago Pneumatic Tool Company nor of Mid-Continent Supply Co., of which Davis is also president.

Cherry Heads PEPA

The Petroleum Electric Power Association has elected its new officers for 1958-59 term at Fort Worth at its 30th annual meeting. The incoming president is Harvey Cherry (middle) of Houston Lighting & Power Company; vice president, D. S. Coffman (left) of Texas Power & Light Company; secretary-treasurer, W. M. Larkin of Gulf States Utilities Company. The following are the new directors for the PEPA for the coming year. Kirby Dalkins, West Texas Utilities, Abilene, Texas; P. B. Ferris, The Empire District Electric Company, Joplin, Mo.; Thomas E. Graham, Oklahoma Gas & Electric Company, Oklahoma City; H. P. Lindsey, Arkansas Power & Light Company, Little Rock, Ark.; J. F. Maddox, New Mexico Electric Service Company, Hobbs, N. M.; Harold S. Nay, Kansas Gas & Electric Company, Wichita, Kan.; John Odom, Texas Electric Service Company, Midland, Texas; R. K. Owen, Southwestern Public Service Company, Amarillo, Texas; and J. L. Satterfield, Pacific Power & Light Company, Casper, Wyo.

Bill Wilson to Manage New Somner Store in Hobbs

The W. L. Somner Company, Inc., announced the opening of a new store at Hobbs, N. M. A complete stock of Gaso pumps, Allis-Chalmers-Buda engines and Marlow pumps, with parts and service facilities, are available. Bill Wilson, transferred from the Odessa store, is manager.

W. L. Brewster Organizes International Export Packers

A new export crating and packing company has been formed in Houston by William L. Brewster, formerly vice president of Lee Construction Corp. It is called the International Export Packers of Houston.

The company will specialize in the packing of heavy machinery, oil field equipments, complete plants, refineries and other items for export to foreign lands.

Bud Lee to Manage Warehouse For Enardo in Odessa, Texas

Enardo Manufacturing Co. has opened a warehouse in Odessa, Texas. Bud Lee, veteran Enardo salesman in the West Texas area, will be in charge of the warehouse, which will stock a full line of Enardo products.

Reorganization Completed By Welex of Canada, Ltd.

Greatly expanded facilities and services have been announced by Welex of Canada, Ltd.

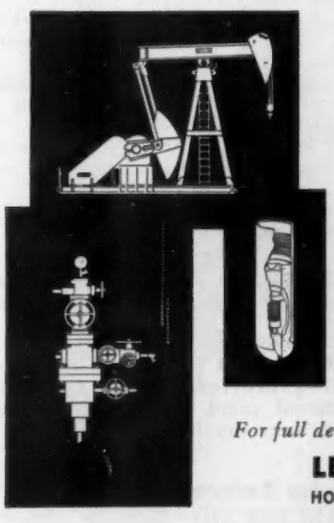
With reorganization of the company completed, the following positions and locations have been announced: Stan Nelner, vice president and manager of operations; H. T. Harvey, Eastern division manager; H. J. Fairbanks, Western division manager. The Eastern division of Welex of Canada, Ltd., has headquarters in Regina and operation districts in Estevan and Sarnia. The Western division is headquartered in Edmonton with operation locations in Edmonton, Drayton Valley, White Court, Red Deer, Calgary and Wainwright.

Pfizer Launches New Project For Secondary Recovery Men

Twenty upperclassmen from top-ranking colleges head out into secondary oil recovery areas of the Southwest next month to carry results of chemical research right to the wellhead. They were engaged in "Program 20," a new kind of technical service project originated by Chas. Pfizer & Co., Inc. The Program 20 men, all chemistry or chemical engineering majors, will use the test information to demonstrate the use of citric acid as a sequestering agent where "iron plugging" of the sandface is a major problem.

"This ain't my kind of Pumping!"

says Mike LE GRAND



who knows a thing or two about pumps and well-head equipment, 'cos he's in for a trouble-free time when Le Grand equipment is in use. Rugged—dependable—built to do its job under all conditions - with a unit to take every kind of load. Also available: LeGrand OCT. Well-head Equipment; LeGrand Howco Floating Equipment; and LeGrand-S.C. Carter Long-stroke Hydraulic Pumping Units.

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For more data on advertised products, use Readers' Service Cards, last page.

PUMPING PROBLEMS SIMPLIFIED

with DARCOVA composition valve cups

DARCOVA valve cups are *the* truly texture-engineered cups that give you exactly the right composition for maximum pumping efficiency and cup life under varying conditions of depth, pressure, temperature, corrosion and abrasion.

Darcova valve cups are available in a complete range of sizes *and* types for your job, and assure maximum production with minimum down-time.

Send for Bulletin No. 5502 and specify DARCOVA at your supply store. There *is* no substitute.

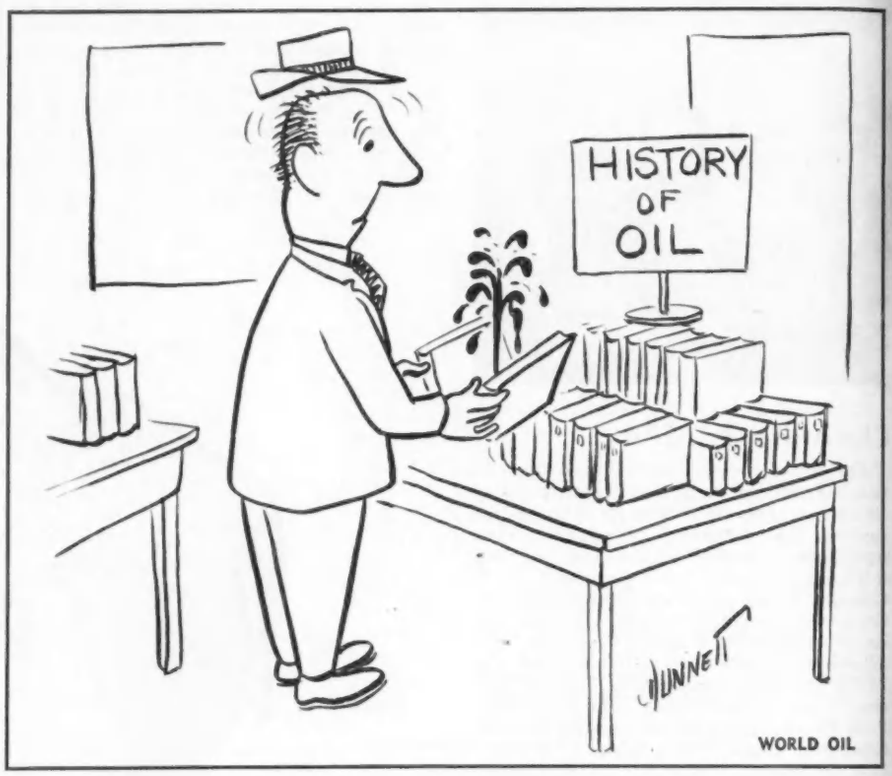
DARLING VALVE & MANUFACTURING COMPANY

DARCOVA ®

THE ORIGINAL COMPOSITION CUP

WILLIAMSPORT 28, PA.

SQUEAKS from the BULLWHEEL



High Living

They were feeling no pain. They were so high they were on Cloud Nine when a jet plane whizzed by. One cat turned to the other, "Man, I thought he'd never leave."

Horse of a Different Color

"Calm down, son," said the father of the marriageable daughter to the fidgeting young man. "I bet you want to marry my daughter and you're shy about asking for her. Well, take her, my boy, marry her and good luck to you."

"Oh, no, it isn't that, Mr. Smith," the suitor answered. "I just wondered if you could lend me $25."

"Lend you $25!" exploded the father. "I should say not! I hardly know you!"

Paradox

Every normal man has two great ambitions. First, to own his home. Second, to own a car to get away from his home.

Ponder This

If a cluttered desk is a sign of a cluttered mind, one can't help wonder what an empty desk indicates.

Praise Before Duty

The boss called the new stenographer into his office. "Miss Gann," he said, "you are the best-looking girl we've ever had working in this office."

A pleased look came into the girl's eyes.

"You dress well," the boss continued, "you have a nice voice, you make a good impression on the public, and your deportment is fine."

"Oh, thank you," she said. "Your compliments are very pleasing."

"Enjoy them to the fullest," returned the boss, "because we are now going to discuss your spelling, punctuation and typing."

Economics

Folks who try to live within their income are just trying to mess up our prosperity.

SECONDARY RECOVERY
Since 1922

PETROLEUM ENGINEERS
CABLE & STEPHENS
WICHITA FALLS, TEXAS

RESERVOIR ENGINEERING
Water Flooding **Gas Repressuring**
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FIELD SUPERVISION
Phone 723-2167

Ed Siever

R. E. Griffin

Cleve Holt

Bill Brandt

Four Sales Managers Appointed By H. C. Smith Oil Tool Company

H. C. Smith Oil Tool Co. has announced four major promotions within the company's sales organization.

Ed Siever has been appointed Mid-Continent sales manager with headquarters in Odessa, Texas. He will supervise all of the company's sales activities with the exception of the Pacific Coast. R. E. Griffin has been appointed Southwestern regional sales manager also with headquarters at Odessa.

Bill Brandt has been appointed Northwest regional sales manager for the company, with headquarters in Garden City, Kan. His territory will include Oklahoma, Kansas, Colorado and Wyoming. Cleve Holt was recently appointed regional sales manager of the Texas Gulf Coast area, including East Texas, Louisiana and Mississippi.

Joy Mfr.'s Oil Field Drill Division Merges With Two Other Phases

In a move expected to provide more efficient manufacturing operations and a more effective marketing program, Joy Manufacturing Company has announced that its Oil Field Drill division at Dallas is being consolidated with two of the company's other divisions.

The manufacturing operations and the marketing of rotary blast hole, and water well drill products, are being consolidated with Joy's Mining and Construction division. The Michigan City, Ind., plant of the Mining and Construction division has been producing similar drills for some time and is well adapted to making these additional products.

The oil field products will be handled through the company's Baash-Ross Division, headquartered in Houston.

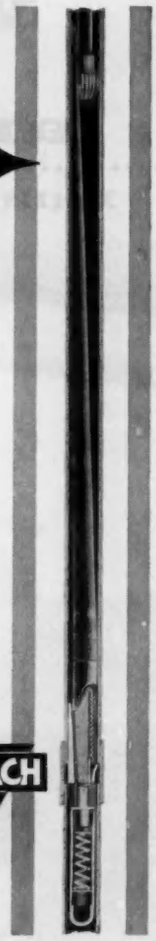
Rogers Geophysical Installs New SIE Office System

Rogers Geophysical Company plans to make a fresh approach to local geophysical problems with the installation at Roswell, N. M., of the latest office seismic data reduction system from southwestern Industrial Electronics—the MS-12/MS-17 GeoData system.

The GeoData provides a wide variety of accurate and informative presentations of seismic information. It can process up to 480 traces taken from up to 20 fm or direct-recorded tapes on a single cross-section.

KINZBACH WHIPSTOCKS

POSITIVE SETTING... SAFE DRILL-OFF



You set your Kinzbach Whipstock at desired depth and position with absolute confidence of positive grip. Trigger assures that whipstock will be set so window will always be in only one joint of pipe. Concave section pivots on one direction hinge above slip section so upper lip always lies against pipe for safe passage of working tools; cannot be hinged into obstructing position.

Whipstock safely, where you want to, and in proper direction with Kinzbach Whipstocks. Available in all popular casing sizes.

KINZBACH TOOL CO., INC.
P. O. Box 277 • HOUSTON, TEXAS
EXPORT: 74 TRINITY PLACE, NEW YORK, N. Y.

"I've ALWAYS preferred KING GA SWIVELS"

King Swivels 32GA and 53GA have been popular for many years. They have proved to be rugged, dependable and durable, and are in use around the world because they are "preferred". The fact that King Oil Tools is the largest manufacturer of lightweight swivels is supporting evidence of King engineering, service efficiency and complete all-around dependability.

INDUSTRY RECOGNIZES KING GA SWIVELS BY THESE FAMOUS FEATURES:
- ALLOY STEELS assure strength with minimum weight.
- PACKING is V-type, often called chevron type.
- WASHPIPES are seamless alloy tubes, case-hardened and ground.
- GREASE LUBRICATION for the packing.
- MULTIPLE BALL BEARING UNITS provide ample capacity.
- OIL BATH LUBRICATION for the bearings.
- Choice of BAIL OR ELEVATOR SHANK.

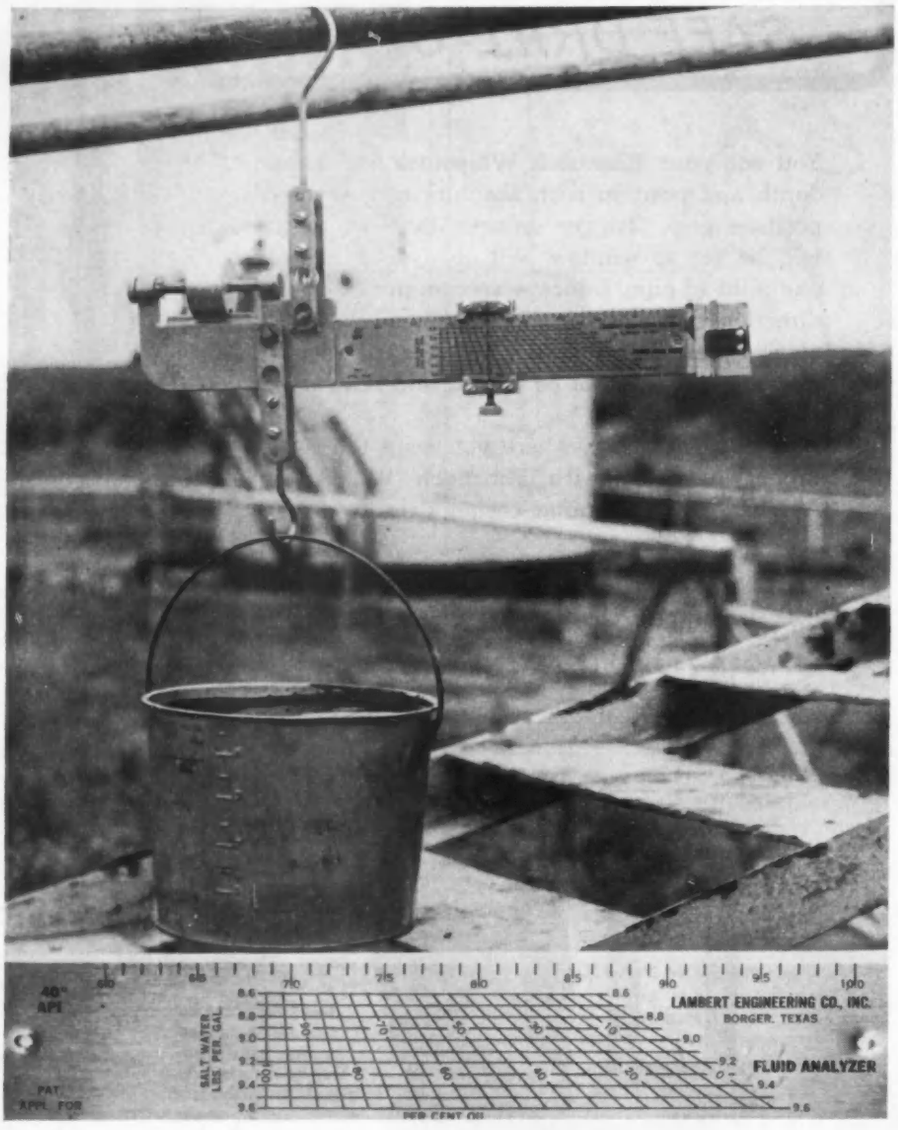
FOR FULL INFORMATION ON ALL KING SWIVELS — SEE YOUR NEAREST DISTRIBUTOR — OR WRITE:

KING OIL TOOLS
P. O. BOX 15146 • HOUSTON 20, TEXAS • ORchard 3-3421

For more data on advertised products, use Readers' Service Cards, last page.

What's New in EQUIPMENT and SERVICES

Drilling - Production - Exploration



Fluid Analyzer

Lambert Engineering Co. has announced production of its fluid analyzer.

To use this device it is first necessary to take a gallon of salt water from the tank battery or separator and weigh it on the beam scales. This will tell the user which horizontal line to use on the chart. With the degree API and salt water weight per gallon known, a gallon of fluid is suspended from the scales as shown in the photograph. Then when the counter-poise is moved to balance the unit, a direct reading of the percent oil in the fluid is read directly from the chart.

Note that the tare weight of the bucket is adjusted out and only the fluid contents are weighed. Stainless steel charts, as shown in the lower part of the photograph are available for each 5 degrees API from 10 through 60 and the chart desired is ordered for the unit at the time of purchase. A pair of pointers, visible in the upper hanger, oppose one another when the beam is in balance, thus assuring accuracy of weight.

For more data, circle **No. E1** on Readers' Service Card, last page this issue.

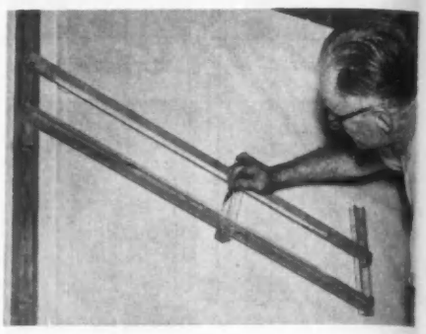
Insulation Protection

Allis-Chalmers has produced an addition to its Super-Seal line that features complete protection for the insulation system by completely casting open-type motor stators in an epoxy resin. Motor applications of this encapsulated motor include the most severe conditions of outdoor service.

In this process, the winding end turns are completely enclosed in a hard, protective case, making them impervious to moisture and resistant to attack by solvents, oils and the most commonly encountered chemicals. The epoxy resin also flows through the slot portions filling them with the same protection. This system is similar to the conventional system in that conductor, phase and slot insulation are used, and these components may be of Class A, B or H materials.

(This item supplements Allis-Chalmers data on Page 169 of the Composite Catalog, 22nd Edition.)

For more data, circle **No. E2** on Readers' Service Card, last page this issue.



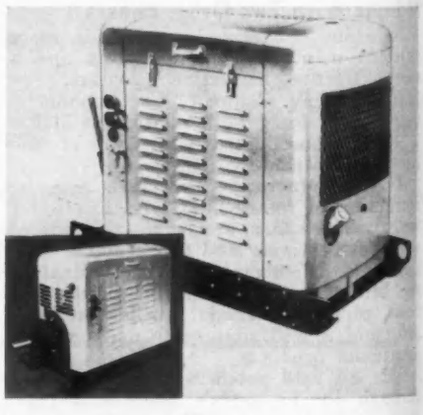
Section Plotter

A semi-automatic seismograph section plotter for use in solving seismic dip migration problems has been developed by Glenn M. McGuckin, seismograph consultant, Norman, Okla. The tool is simple and fast to operate, adaptable to split-spread plotting, plotting half-spreads, and the use of curved ray paths. Its construction is simple, sturdy and inexpensive.

The device consists of two scale arms, or plotting bars, connected by a head and foot bar so the assembly always constitutes a parallelogram. This parallelogram assembly slides back and forth in a channel in the long fixed base bar above the top edge of the cross-section paper. A T-square scribing bar slides along the plotting bars and is used to locate the reflecting horizon on the cross-section.

Identical time-depth scales, appropriate to the local velocity conditions, are cemented in recesses in both plotting arms.

For more data, circle **No. E3** on Readers' Service Card, last page this issue.



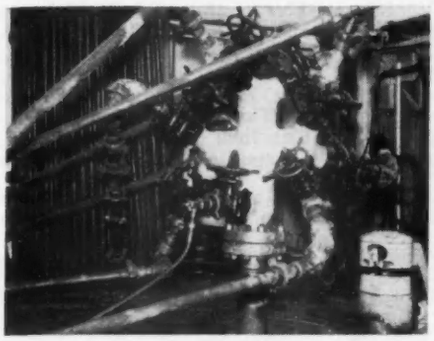
Heavy Duty Power Unit

The new heavy duty Jeep six-cylinder engine has now been incorporated into a complete power unit package according to spokesmen at the Industrial Engine department of Willys Motors Inc.

The skid-mounted unit is enclosed in an easily accessible sheet metal housing. A radiator, muffler, 8.6 gallon gasoline tank, No. 4 SAE bell housing, and other basic accessories are all assembled for immediate operation on delivery. Governors, industrial type fly wheel and other optional equipment are available.

For more data, circle **No. E4** on Readers' Service Card, last page this issue.

PRODUCTION



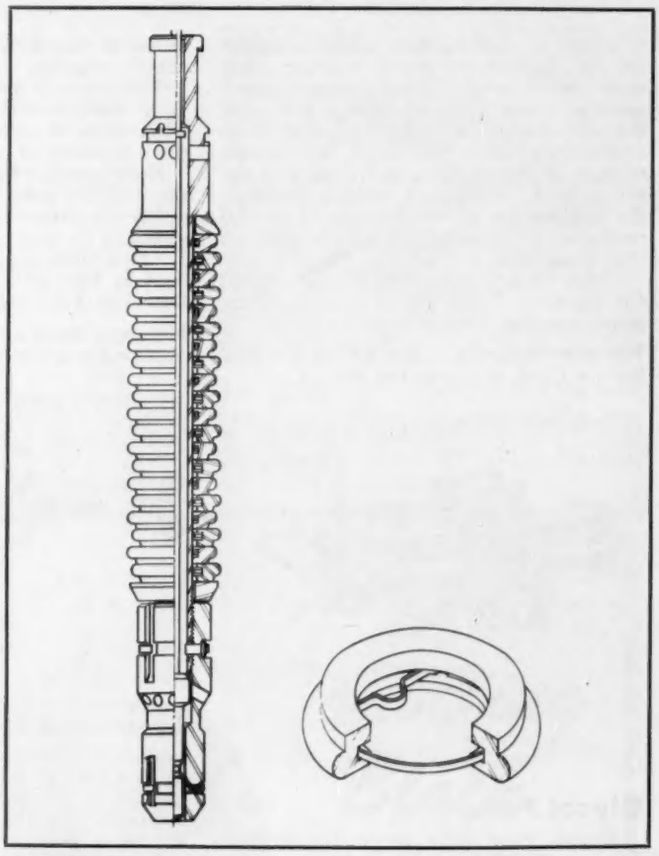
Frac Header

Dowell engineers have designed, tested and put into use a new type frac header for oil and gas well fracture treatments. This new header is the result of a two-year research and field development program to minimize the hazards that are always present on high volume—high fracture treatments.

The new header is fabricated from AISI 8630 steel and subjected to several specifications and testing procedures. Final tests are equivalent to the federal tests for armor plate. Each casting is subjected to 100 percent radiographic and magnaflux analyses. After heat treating, all parts have a Brinell hardness averaging 255 and a minimum yield strength of 100,000 pounds per square inch. The assembled head is tested at 7,000 psi on casing and 10,000 psi on tubing.

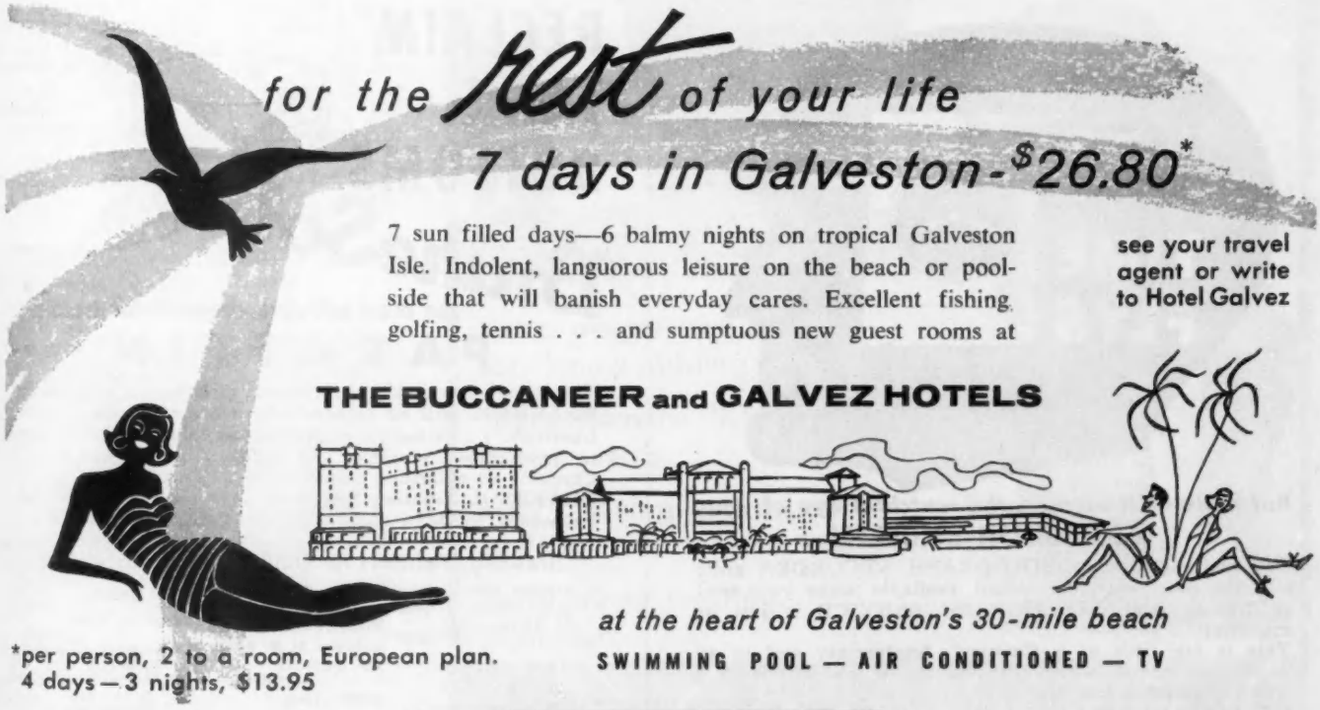
(This item supplements Dowell Incorporated data on Pages 1513-1532 of the Composite Catalog, 22nd Edition.)

For more data, circle **No. E5** on Readers' Service Card, last page this issue.



Well Plunger

Spring-loaded wobble washers comprise the key feature of a new oil and gas well plunger which has just been introduced by the Harold Brown Company.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7 days in Galveston - $26.80*
7 sun filled days—6 balmy nights on tropical Galveston Isle. Indolent, languorous leisure on the beach or poolside that will banish everyday cares. Excellent fishing, golfing, tennis . . . and sumptuous new guest rooms at
see your travel agent or write to Hotel Galvez
THE BUCCANEER and GALVEZ HOTELS
at the heart of Galveston's 30-mile beach
SWIMMING POOL — AIR CONDITIONED — TV
*per person, 2 to a room, European plan.
4 days — 3 nights, $13.95

AFFILIATED NATIONAL HOTELS

AIR CONDITIONED
TELEVISION
RADIOS

ALABAMA: Mobile—the Admiral Semmes; Birmingham—the Thomas Jefferson. **WASHINGTON, D. C.**—the Washington. **INDIANA:** Indianapolis—the Claypool. **LOUISIANA:** New Orleans—the Jung and the De Soto. **NEBRASKA:** Omaha—the Paxton. **NEW MEXICO:** Clovis—the Clovis. **SOUTH CAROLINA:** Columbia—the Wade Hampton. **TEXAS:** Austin — the Stephen F. Austin; Brownwood — the Brownwood; Dallas—the Baker and the Travis; El Paso—the Cortez; Galveston — the Buccaneer, Galvez, Seahorse, Jean Lafitte and Coronado Court; Laredo — the Plaza; Lubbock — the Lubbock; Marlin — the Falls; San Angelo—the Cactus; San Antonio—the Menger and the Angeles Courts. **VIRGINIA:** Mountain Lake — the Mountain Lake; Norfolk—the Monticello.

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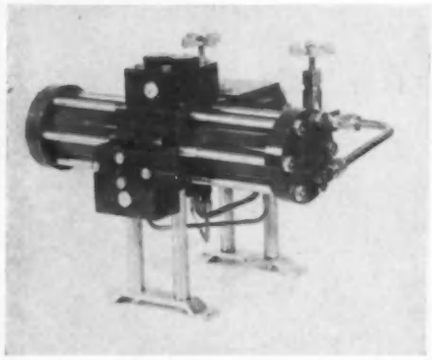
Free Inter Hotel Teletype Reservation Service

While wobble washers were employed on the predecessor model plunger, they were free-floating. The spring-actuated washers affect an even tighter seal with the tubing wall and remove paraffin more efficiently. There are some 24 wobble washers in the plunger, and these ride the tubing wall continuously, wiping fluid into the seal section of the plunger. This also prevents soft paraffin from hardening on the tubing wall.

(This item supplements Harold Brown Co. data on Pages 871-873 of the Composite Catalog, 22nd Edition.)

For more data, circle **No. E6** on Readers' Service Card, last page this issue.



Glycol Pump

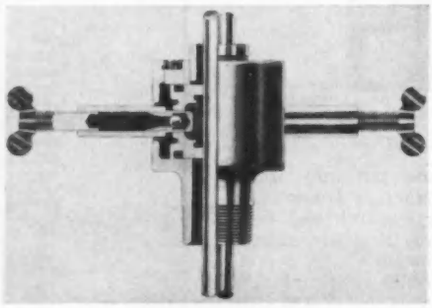
A new check valve system for the new PC Series glycol pump is announced by Kimray, Inc. All check valve piping has been eliminated by the use of two check valve blocks which house the suction and discharge checks required for the double action principle.

This pump is used for circulating glycol in a closed system, gas dehydration unit. The source of power is wet glycol and a small quantity of gas at absorber pressure.

High pressure liquid level controllers on the absorber may be eliminated since the pump discharges wet glycol from the absorber.

(This item supplements Kimray, Inc., data on Page 2845 of the Composite Catalog, 22nd Edition.)

For more data, circle **No. E7** on Readers' Service Card, last page this issue.



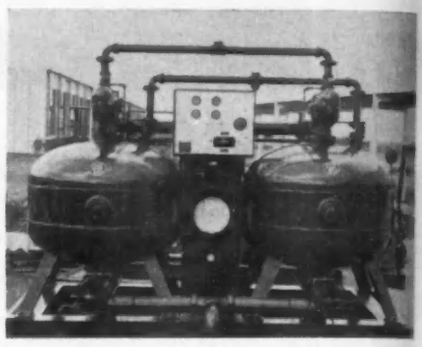
Improved Stuffing Box

A new polished rod stuffing box of improved design which assures free lateral movement of the floating gland, is now available from Kinzbach Tool Company, Inc. It is designated as Type 241.

Lateral movement of the floating gland compensates for any misalignment of the polished rod. It is packed with an especially developed plastic packing which is self-lubricated, will not adhere to the rod or burn out if the well pumps off. Additional packing may be inserted into the stuffing box gland through lateral tubes at any time without shutting-in the well. This permits a fully-packed gland to be maintained at all times at very low cost, since it is never necessary to replace the packing in the sense that ring-type packings, in sets, must be replaced.

(This item supplements Kinzbach Tool Co., Inc., data on Pages 2873-2892 of the Composite Catalog, 22nd Edition.)

For more data, circle **No. E8** on Readers' Service Card, last page this issue.



Custody Transfer Unit

Extreme accuracy is the outstanding feature of the new Type LACT automatic custody transfer unit manufactured by Garrett Oil Tools Inc., a division of U. S. Industries, Inc.

The unit measures gross fluid as it is produced and records total volume, auto-

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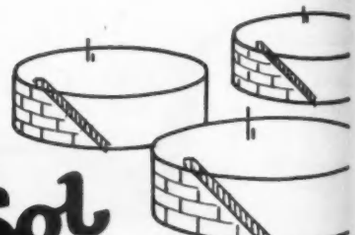

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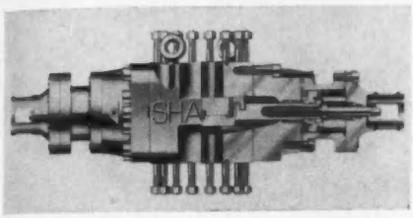
matically corrected to oil at 60° F., on a direct-reading mechanical counter.

The Garrett LACT unit uses two fluid volume meters, synchronized and interlocked to provide practically continuous delivery of metered oil. The interlocking system assures that each vessel is completely filled before the flow is switched to the other vessel.

(This item supplements Garret Oil Tools, Inc., division of U. S. Industries, Inc., data on Pages 1965-2000 of the Composite Catalog, 22nd Edition.)

For more data, circle **No. E9** on Readers' Service Card, last page this issue.

DRILLING



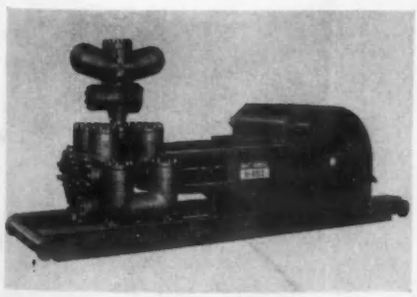
Hydraulic Gates

Shaffer Tool Works has produced a large bore blowout preventer for handling pressures of 10,000 psi (15,000 psi test pressure).

Shaffer XHP hydraulic gates are the latest Shaffer advancement and incorporate basic design principles that have already been field-proven. For example, the efficient Shaffer "in-line" ram-piston design is found in the XHP units. By eliminating multiple hydraulic pistons and complicated connections between pistons and rams, Shaffer's "in-line" design reduces seals, parts and maintenance to an absolute minimum. Moreover, the hydraulic thrust is directly behind each ram for maximum effectiveness.

(This item supplements Shaffer Tool Works data on Pages 4721-4816 of the Composite Catalog, 22nd Edition.)

For more data, circle **No. E10** on Readers' Service Card, last page this issue.



Slush Pump

The National H-850 slush pump is announced by The National Supply Company. The new H-850 pump has a rated input of 850 hp and hydrostatic test pressure of 8,000 pounds per square inch in the fluid cylinder. Bore is 8 inches maximum and stroke 15 inches.

Principal objectives in developing this pump were to provide higher power with less weight and better portability. The main frame is made of steel plates and steel castings which are welded into one unit. The fluid end is a one-piece, high-strength steel casting with no internal baffles or walls.

Design of the H-850 increases fatigue life in the fluid cylinder, reduces wear of the cylinder bore, and increases liner packing life.

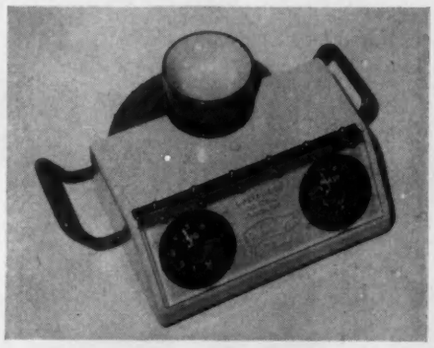
(This item supplements The National Supply Company data on Pages 3641-3752 of the Composite Catalog, 22nd Edition.)

For more data, circle **No. E11** on Readers' Service Card, last page this issue.

Control Indicator

A new Safety-Weigh control indicator is now offered to indicate guy line loads and changes, pipe mast or portable derrick foundation loads and changes, wind loads on portable derricks, load on rods when pulling stuck pumps, load on swab line and load on tubing pulls.

The Safety-Weigh sits under the pole or derrick mast adjusting screw and the mast foundation, taking the place of the conventional steel base plate.



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New Literature

For more data on New Equipment or copies of Catalogs and Literature reviewed in this issue, use the Readers' Service postcards just inside the back cover and facing the Advertisers Index. Simply circle code numbers of items desired—sign and mail card. Requests are transmitted to the manufacturer as soon as received by us for mailing of desired information directly to you.

Welding Supply Catalog

A new 48-page catalog on supplies and accessories for gas and arc welding is now available from Air Reduction Sales Company.

Presented in this catalog, which contains over 100 illustrations, is complete information on ferrous and non-ferrous welding rods for oxyacetylene welding and Heliwelding; brazing alloys; Jackson and Airco protective equipment including goggles, glare protection spectacles, cap and goggle combinations, welding helmets and face shields, hard hats, headgear and pocket shields; leather welding gloves; weld cleaning tools; and many other items.

To get a copy, circle **No. E13** on Readers' Service Card, last page this issue.

Diesel Bulletin

A 12-page illustrated brochure entitled "There is a Difference in Diesels" has been released by the Detroit Diesel Engine division of General Motors. Covered are topics such as diesel vs. gasoline engines, the difference in two-cycle and four-cycle engines, fuel systems, parts interchangeability, service and others.

To get a copy, circle **No. E14** on Readers' Service Card, last page this issue.

Sling Handbook

A fully-illustrated 40-page reference book that covers more than 80 subjects on Tuffy slings and fittings is now being offered by the Union Wire Rope Corporation.

Included in the new edition is new reference information condensed into handy chart form on sling types, dimensions and rated loads. In addition, the section of Tuffy sling fittings has been expanded to cover many fittings not previously shown, together with reference charts on sizes, rated loads, etc.

To get a copy, circle **No. E15** on Readers' Service Card, last page this issue.

Magnetic Valve Release

Within its 24 pages Catalog V-58 illustrates and lists specifications of magnetic and motorized valves for use with air, water, gas, steam, oil and refrigerants. Also included are solenoid coil rating tables. Another feature consists of two flow charts—one for liquids, the other for compressible fluids. Dimensional drawings are included.

To get a copy, circle **No. E16** on Readers' Service Card, last page this issue.

Hurricane Booklet

The devastation of Cameron, La., by Hurricane Audrey June 27, 1957, and the outstanding contributions of the oil industry to its subsequent rehabilitation are recalled in a special Audrey anniversary brochure issued by Mud Supply Company, Inc., a division of Magnet Cove Barium Corporation.

Mud Supply has its headquarters at Lake Charles, La., and participated in the rescue work at the time of the disaster.

The new brochure, entitled "Audrey Report," pictorially presents the ruin and suffering left in Audrey's wake and the oil industry's spontaneous response to the town's need for help.

To get a copy, circle **No. E17** on Readers' Service Card, last page this issue.

Stabilizer Bulletin

The driltrol Corporation has just released a new six-page folder on the firm's drillable wing stabilizer. The illustrated folder explains construction features and the tool's various applications as a stabilizer, fulcrum, hole straightener, key seat guide and preventative for pressure differential sticking.

To get a copy, circle **No. E18** on Readers' Service Card, last page this issue.

Wire Rope Folder

Leschen Wire Rope Division, H. K. Porter Company, Inc., has announced a new 16-page illustrated booklet on "How to Be a Wire Rope Expert." Designed for everyone who buys, sells or uses wire rope, it describes in easily understandable language the basic principles governing the selection of the proper rope construction for any job.

To get a copy, circle **No. E19** on Readers' Service Card, last page this issue.

Engineering Data

Introducing a new line of high-reliability gages, Kunkle Valve Company offers a 48-page catalog illustrating gages with ranges from 15 psi or 30 inches of vacuum, to 20,000 psi plus complete engineering data and selection tables for applications in processing plant and power instrumentation.

To get a copy, circle **No. E20** on Readers' Service Card, last page this issue.

Computer Reports

Of interest to petroleum engineers and geologists is a set of four oil production problems solved by the Bendix G-15 digital computer. The problems, solution and method computation are described in these illustrated reports under the titles "Seismic Migration," "Material Balance," "Second Vertical Derivative" and "Water Drive Problem."

To get a copy, circle **No. E21** on Readers' Service Card, last page this issue.

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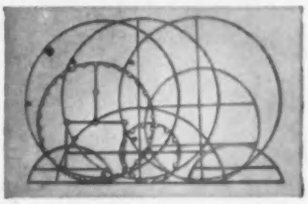

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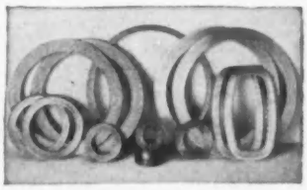

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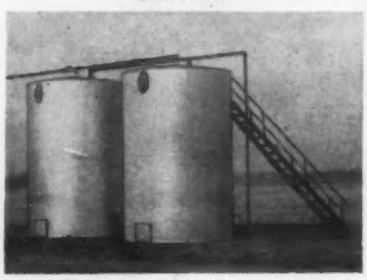

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